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Original Research Article

Visual Acuity Loss and Prevelance of Colour Vision Deficiency amongst Secondary School Students in Ogoja Urban, Cross River State, Nigeria

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Abstract

Visual acuity loss and colour defects among young adults often times occur without notice. The aim of this study was to determine the visual acuity status and colour defects amongst secondary school subjects in Ogoja urban of Cross River state, Nigeria. A descriptive cross-sectional study was conducted using the multi- stage sampling technique amongst 500 secondary school students in Ogoja urban. The standard Snellen's chart was used to assess visual acuity. The Ishihara chart Plates 1-15 of the 2008 edition of the Ishihara's colour album were used to detect colour defects. The mean age of the subjects was 13.33 ±0.12 years for the male subjects while that for the females was 12.83 ±0.16 years. The heights of the male subject was 165.01 ±1.22cm while that for the females was 153.53 ±1.24cm, with the males being taller than the females ($p<0.001$); but the body weights did not differ. The visual acuity did not differ between the male and female subjects. However, when the visual acuity was categorised, only 80 subjects (16.1%) for the right eye and 77 subject (15.5%) for the left eye had normal visual acuity (6/6 to 6/8). The bulk of the other subjects belonged to the categories of mild (6/9 to 6/18), moderate (6/19 to 6/48) to severe (6/49 to 6/60) impairment in visual acuity: 235(47.2%) and 238(47.8%) for the right and left respectively having mild visual impairment; 78(15.7%) and 78(15.7%) for right and left respectively having moderate visual impairment; severe visual impairment was seen in 105(21.1%) and 105(21.1%) for the right and left eyes respectively. The frequency of distribution of colour defects amongst the secondary school subject showed that 0.75% of the subjects studies were red colour blind while 2.46% of the subjects were red-green colour blind. Therefore, in this population with a perceived normal visual acuity, the percentage of subject with visual impairment seemed higher than those with normal visual acuity. It is not clear what could be responsible for this.

Keywords: Visual acuity, colour vision, Ogoja urban.

INTRODUCTION

Visual perception is a very critical component of life that when defective may affect the very existence of a living creature. In humans, visual perception can be assessed as either visual acuity or as colour vision.

In a report of Holden *et al.*, [1] an estimated 2.3 billion people worldwide suffer from one refractive error or the other, most of whose defects are correctable. Out of this number only 1.8 billion people have access to eye examinations and affordable correction, leaving approximately 500 million people, mostly in developing countries, and many children, with uncorrected error causing blindness and impaired vision [1]. This is worrisome particularly among adolescents of secondary school age as these visual defects can negatively affect the education of the child.

Even though many people in a given society may uphold that a deficiency in colour vision noticed in them from holistic experiments, may not interfere with their daily life. It is also reported that people with colour vision defects come up with adaptive techniques to survive their daily routine and this is one of the major reasons why most people with colour blindness are not aware of their visual deficiency [2].

In a study conducted by Ishihara in 2008, he identified that deficiencies in colour vision which are congenital form the commonest forms of colour vision abnormalities and are characterized by "red-green" deficiency which may be red colour blindness or green colour blindness. He called the red colour blindness as protan defect while the green colour blindness as a Deutan defect [3]. These red and green colours appear as grey or dark while blue and other colours appear very clear [4] referred to inherited colour vision deficiency (CVD). Colour deficiencies are an indication of associated microscopic anatomical and structural abnormalities in the retina where numerous photoreceptors are at work for respective colours.

Anatomical descriptions further reveal that colour vision deficiency is not only associated with abnormalities in the retina but is also associated with the lateral geniculate body and area VI of the visual cortex. Furthermore Almog & Nemet [5] reported that there may be other symptoms of colour vision deficiency. From his reports, subjects with colour vision deficiency also have disorders like muscular diseases, optic neuropathic and amblyopia.

Visual acuity is a measure of the spatial resolution of the visual processing system. Acuity is a measure of visual performance and does not relate to the eyeglass prescription required to correct vision. Instead an eye examination seeks to find the prescription that will provide the best corrected visual performance achievable [6].

Daylight vision (i.e photopic vision) is sub served by cone receptor cells, which have high spatial density (in the central fovea) and allow high acuity of 6/6 or better. In low light (i.e isotopic vision), cones do not have sufficient sensitivity and vision is sub served by rods. Spatial resolution is then much lower. This is due to spatial summation of rods i.e a number of rods emerge into a bipolar cell and the resulting unit for resolution is large and acuity small. It is pertinent to note that there are no rods in the very center of the visual field (the foveola) and highest performance in the low light is achieved in near peripheral vision [6]. Thus, according to Ali & Klyne [7] visual acuity or resolving power is the property of cones. They also opined that Acuity and colour vision, despite being mediated by the same cells, are different physiologic functions that do not interrelate except by position. Thus, that visual acuity and colour vision can be affected independently. A key factor in obtaining detailed vision however is inhibition. This is mediated by neurons such as the amacrine and horizontal cells, which functionally render the spread or convergence of signals inactive. Any visual deprivation that is interfering with such input over a prolonged period of time such as a cataract, severe eye turn or strabismus will usually result in a severe and permanent decrease in visual acuity and pattern recognition in the affected eye if not treated early in life, a condition known as amblyopia [7].

The visual experience of a child plays a significant role in his psychological, physical and intellectual development. Many of the causes of visual impairment in childhood are avoidable, either being preventable or treatable [8].

Many people have the notion that as long as they can see clearly read and write, then they have no inherent or latent visual deficiencies. This may not be correct in its entirety as even when some individuals are able to read, write and differentiate different colours, they may still have some form of colour/visual deficiency. Although research on visual acuity and colour defects may have been done in other areas, none of such studies have been done particularly among teenagers of secondary school age around the Ogoja area. It was therefore the aim of this study to assess the prevalence of visual acuity and colour vision defects among Secondary School Students in Ogoja Local Government (Urban) of Cross River State, Nigeria.

MATERIALS AND METHODS

The Study Area

Descriptive cross-sectional survey was conducted to determine the prevalence of colour deficiency and its correlation with refractive error among secondary school students in ogoja LGA urban Cross River state Nigeria. Ogoja is a Local Government Area of Cross River State Nigeria, with a population of about 171,901 and an area of 972km. it consists of many tribal units, including Ishibori and igoli as the central town. It has boundaries with Yala to the west, Bekwarra in the southwest, Obudu in the east and Boki in the south east. There are diverse natural heritage in the area but majority of the people are engage in subsistence agriculture.

The Sample

Five hundred Subjects were selected from the population in the study area

Inclusion Criteria

- Male and Female children above 8 years of age in selected schools within the area under investigation.
- Children who are willing to participate in the study
- Children who are present at the time of data collection

Exclusion Criteria

- Children under the age of 8 years.
- Children who are not willing to participate in the study
- Children who are not present at the time of data collection
- Children who are unable to read and write numerals

Sampling Procedure

Random Sampling

Five hundred students were selected from each school used, 250 males and 250 females respectively. Purpose of the study and technique to be used were explained to each subjects.

Ethical Clearance/Approval

Approved consent was obtained first form the Principals of the secondary schools used for the research and then from the students who served as the subjects for the research. The students duly informed about the test and the procedure of the test before allowing them to participate in the tests. Participation in

the test was purely voluntary. Ethical approval was also obtained from the Ministry of Health, Calabar, Health Research Ethics Committee (HREC) Calabar, Cross River State.

Instrument and Procedure for Data Collection

For colour vision, Plates 1-15 of the 2008 edition of the Ishihara's colour album were used. The individual plates or charts have symbols composed of numerous disks of varying colours and brightness. The backgrounds for the symbols are similarly configured but have colours that can be differentially discriminated by persons with normal versus defective colour vision. Only small differences are present between the symbol and background to make the charts sensitive enough to allow subjects with normal colour vision to pass. The standard Snellen's chart was also used to asses visual acuity. The chart was placed 6 meters away from the subject and the subjects were tested one eye at a time.

Plates 1-15 of the 2008 edition of the Ishihara's colour album were administered to the subjects. The subjects were screened with plates 1,3,5,10 and 13. Those judged according to the Ishihara's Criteria to be possible colour defective were retested with the full set of plates 1-13. If the defect was ascertained then plates 14 and 15 were used to determine the type of red-green defect. Of the plates 1-15, if 13 or more plates were read correctly, the colour vision was regarded as normal if only 9 or less than 9 plates were read normally, the colour vision was regarded as red-green deficient and thus classified as colour blind. Among the colour blind individuals, those who read not more than two plates as either normal or red-green defective are classified as totally colour blind (monochromats) while the red-green defectives (dichromats) were further classified as deutans or protans based on their ability to read plates 14 and 15 correctly. Subjects were tested 2 or 3 at a time standing about 75cm apart from the plates, which were held so that there was no glare. Subjects were given about 3 or 4 seconds to read and write the number seen in a plate.

Visual acuity was tested in each eye separately, in line with standardized measurements of visual acuity [9]. This was measured with Snellen's chart showing letters. Subjects were tested at standard distances of six and nine meters away. The Snellen chart was hung on a wall at a distance of 6 meters in a well-lit room at a height of 2 meters. Visual acuity was measured with one eye at a time with each subjects standing and facing the chart and then reading out the letters on the charts starting from the biggest one to the smallest one. The eye not being measured was covered with a palm-hand. The number of letters the subjects were able to see at this distance was recorded.

Method of Data Analysis

The data obtained was presented in tables, bars and charts based on simple percentages. The level of significance in chi square tests determined whether the numbers of affected persons in two groups were different from each other at 1 % ($P<0.001$, dfs=1).

Validity of Ishihara Test Plates

Ishihara's test plates are standard tools proved to be effective for the diagnosis of red-green colour vision deficiencies but unreliable when used alone to test for acquired colour vision defects. The test is not useful for detecting blue-yellow patterns of defect in differential diagnosis. Ishihara's test confirms that subjects have normal trichromatic vision but it cannot be used to grade overall colour discrimination ability [10, 3].

RESULTS

Comparison of the ages of male and female subjects of some secondary schools in Ogoja Urban, Cross River State, Nigeria

Fig-1 shows a comparison of the ages of subject of some secondary schools in Ogoja Urban in Cross River state of Nigeria. The mean ages for the male subject was 13.33 ±0.12 years while that for the females was 12.83 ±0.16 years. The ages of the male subject were higher than those of the female ($p< 0.05$).

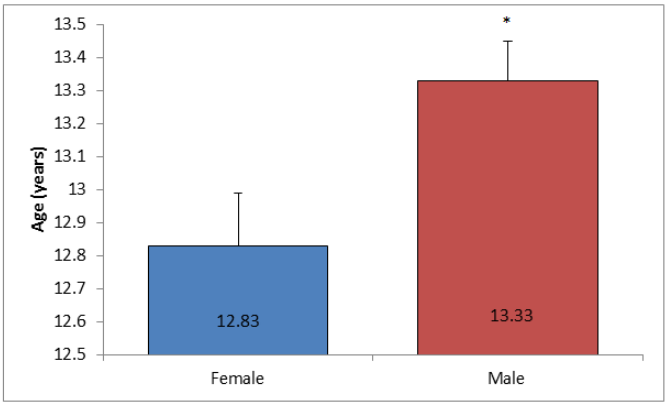

Fig-1: Comparison of the ages of male and female subjects of some secondary schools in Ogoja Urban, Cross River State, Nigeria

* - $p< 0.05$ vs female subjects

Comparison of the height of male and female subjects of some secondary schools in Ogoja Urban, Cross River State, Nigeria

Fig-2 shows a comparison of the height of subject of some secondary schools in Ogoja Urban in Cross River state of Nigeria. The mean height for the male subject was 165.01 ±1.22cm while that for the females was 153.53 ±1.24cm. The values of the male subject were higher than those of the female ($p< 0.001$).

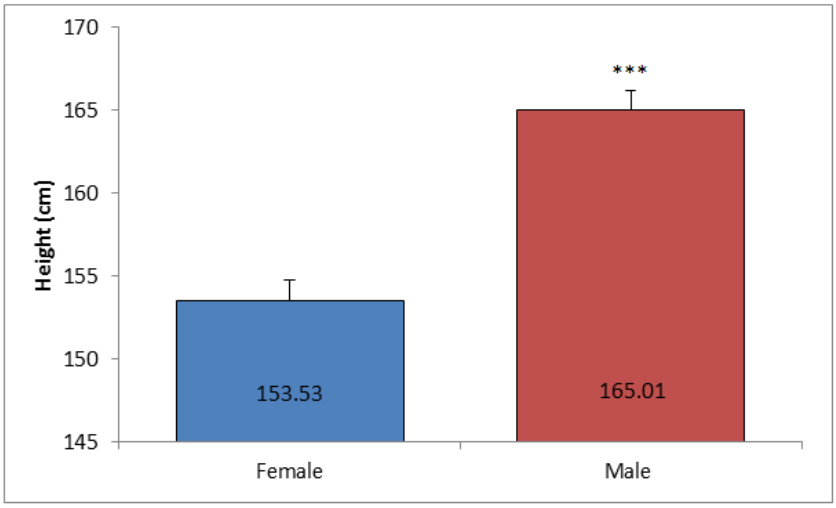

Fig-2: Comparison of the height of male and female subjects of some secondary schools in Ogoja Urban, Cross River State, Nigeria

*** - $p< 0.001$ vs female subjects

Comparison of the body weights of male and female subjects of some secondary schools in Ogoja Urban, Cross River State, Nigeria

The comparison of the body weights of subject of some secondary schools in Ogoja Urban in Cross River state of Nigeria are shown in Fig-3 below. The mean body weight for the male subject was 41.68 ±0.61kg while that for the females was 40.28 ±0.70kg. These body weights did not differ between the male and female subjects.

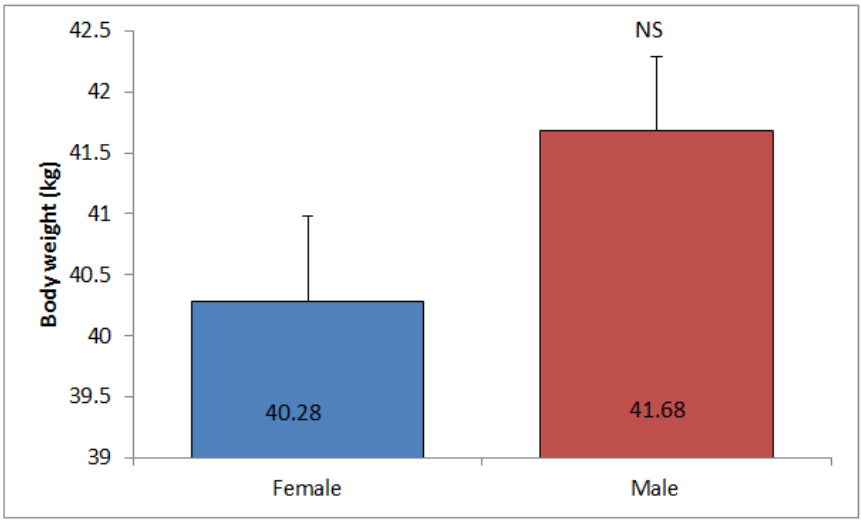

Fig-3: Comparison of the body weights of male and female subjects of some secondary school age in Ogoja Urban, Cross River State, Nigeria

NS – Not significant vs female subjects

Comparison of the mean visual acuity of male and female subjects of some secondary schools in Ogoja Urban, Cross River State, Nigeria

Table-1 below shows the mean visual acuity of the male and female subject of some secondary schools in Ogoja Urban. There didn't seem to be any significant difference in the visual acuity between the male and female subjects; and between the right and left eyes.

Table-1: Mean visual acuity of male and female subjects

	Female (n =180)	**Male (n =318)**
Right visual acuity	25.05 ±1.54	22.42 ±1.10
Left visual acuity	22.50 ±1.53	22.50 ±1.10

Values are presented as mean ±SEM

The frequency distribution of right and left vision loss for male and female subjects of some secondary schools in Ogoja Urban, Cross River State, Nigeria

Table-2 below shows the frequency distribution of right and left vision loss of the male and female subject of some secondary schools in Ogoja Urban. This table shows that the subjects with normal vision (6/6) were only 16.1% for the right eye and 15.5% for the left eye. The others fall within the categories of mild, moderate and severe visually impaired.

Table-2: Frequency distribution of right and left vision loss

	Range of visual acuity	**Right side**	**Left side**
Normal vision	6/6 to 6/8	80 (16.1%)	77 (15.5%)
Near normal (mild) vision	6/9 to 6/18	235 (47.2%)	238 (47.8%)
Moderate visual impairment	6/19 to 6/48	78 (15.7%)	78 (15.7%)
Severe visual impairment	6/49 to 6/60	105 (21.1%)	105 (21.1%)

Values are presented as frequency and percentage (in parenthesis)

The frequency distribution of right and left visual impairment in male and female subjects male and female subjects of some secondary schools in Ogoja Urban, Cross River State, Nigeria

Table-3 below shows the frequency distribution of right vision impairment in male and female subject of some secondary schools in Ogoja Urban. For the right eye, the males with normal vision (6/6 to 6/8) formed 5.0% of the subjects studied while the females were 11.0% of the subjects studied. The larger percentage of subjects studied fell in the categories of mild, moderate and severely visually impaired.

A similar trend was observed for the left eye as seen in Table 4. In both the right and left eyes studied, there were no differences between the male and female subjects.

Table-3: Frequency distribution of right visual impairment in male and female subjects

	Range of visual acuity	Female (n =180)	Male (n =318)	Total
Normal vision	6/6 to 6/8	25 (5.0%)	55 (11.0%)	80 (16.1%)
Near normal (mild) vision	6/9 to 6/18	84 (16.9%)	151 (30.3%)	235 (47.2%)
Moderate visual impairment	6/19 to 6/48	29 (5.8%)	49 (9.8%)	78 (15.7%)
Severe visual impairment	6/49 to 6/60	42 (8.4%)	63 (12.7%)	105 (21.1%)
	Total	180 (36.1%)	318 (63.9%)	498 (100%)

Chi Cal. = 1.559; df = 3; p = 0.669

Table-4: Frequency distribution of left visual impairment in male and female subjects

	Range of visual acuity	**Female (n =180)**	**Male (n =318)**	**Total**
Normal vision	6/6 to 6/8	25 (5.0%)	52 (11.0%)	77 (15.5%)
Near normal (mild) vision	6/9 to 6/18	86 (17.3%)	152 (30.5%)	238 (47.8%)
Moderate visual impairment	6/19 to 6/48	27 (5.4%)	51 (10.2%)	78 (15.7%)
Severe visual impairment	6/49 to 6/60	42 (8.4%)	63 (12.7%)	105 (21.1%)
	Total	180 (36.1%)	318 (63.9%)	498 (100%)

Chi Cal. = 1.2.06; df = 3; p = 0.751

The frequency distribution of colour defects in the different fields of the Ishihara charts for subjects of some secondary schools in Ogoja Urban, Cross River State, Nigeria

Table-5 below shows the frequency distribution of colour defects in the different fields of the Ishihara charts for male and female subject of some secondary schools in Ogoja Urban. Out of the subjects studied, 96.79% of the subjects had normal colour vision. Only 0.75% of the population had red colour blindness whereas 2.46% had red-green colour blindness.

Table-5: Frequency distribution of colour defects in the different fields utilized

	Normal	Red	Red-Green
F1	486	1	11
F2	489	0	9
F3	487	2	9
F4	483	3	12
F5	482	1	15
F6	476	3	19
F7	469	14	15
F8	481	2	15
F9	475	2	21
F10	483	4	11
F11	481	5	12
F12	480	10	8
F13	486	4	8
F14	486	3	9
F15	485	2	10
Mean	**481.93**	**3.73**	**12.27**
SEM	**1.37**	**0.95**	**1.03**
%	96.79	0.75	2.46

DISCUSSION

The standard Snellen's chart was used to assess the visual acuity of subjects of some secondary schools in Ogoja urban of Cross River State. The Ishihara's album was also used to screen for colour vision among these subjects. Familiarization with all the colours was not necessary since the answer is given in terms of numbers and not in terms of colours. Some anthropometric measurements were also taken from the subjects.

When compared between the male and female subjects of the secondary schools, the ages of the male subjects were higher than those of the females. Thus the males in the secondary schools were older than the females. Accordingly, the heights of the male subjects were more than that of their female counterparts. This seemed consistent as expected that the age of the subjects relate correlates positively with their ages. The body weights of the male and female subject however did not differ. Thus, even though the males in these schools seemed to be older and taller than their female counterparts, both of them weighed approximately the same.

When the visual acuity for the left and right eyes were assessed and compared between the male and female counterparts, there were no significant differences between male and female subjects.

The visual acuity was categorized as Normal when it was 6/6 to 6/8 or Near normal or mild visually impaired when it was 6/9 to 6/18. Moderate visual impairment was defined as 6/19 to 6/48 while severe visual impairment was defined as 6/49 to6/60. The frequency of distribution of the visual impairment according to the categories above show that only 16.1% and 15.5% of the subjects had normal vision in the right and left eye respectively.

By implication, 83.9% and 84.5% of these subjects have visual impairment in the right and left eyes respectively. It is not clear why the large percentage of visual impairment in this subjects of secondary school age. This certainly begs the question why such a large prevalence of visual impairment.

Based on the above categorization of visual acuity, the visual acuity was compared between the male and female subjects. Here the visual acuity did not differ between the male and female subjects, but it differed between the categories. The number of female subjects with normal visual acuity for the right eye formed 5.0% of the subjects studied, while those for the males were 11.0%. Here again, it points to the high percentage of subjects with some mild/moderate to severe forms of visual impairment. A similar trend was observed for the left eye.

The prevalence of colour vision deficiency as observed in this study showed that 2.46% of the subjects had red-green colour blindness while 0.75% of the subjects had red colour blindness. The percentage prevalence of the red-green blindness is close to the values of some other studies such as that of Ubom [11] which was 1.87% (28 of 1500 subjects). Roberts [12] had observed in separate studies frequencies of 1.81% in Northern Nigeria, 3.33% in Southwest Nigeria and 2.11% in the Niger delta. Comparison of each of these Nigerian samples with values in the present study showed that there was no significant difference in the prevalence of congenital colour blindness among Nigerian populations in spite of the differences in habitat between the Northern and Southern regions.

CONCLUSION

Although the male subjects in the secondary schools in Ogoja Urban seem older and taller than their female counterparts, their weights approximated. The visual acuity did not differ between the male and female subjects; neither did it differ between the right and left eyes. However, the frequency of distribution of the visual acuity loss showed a large percentage of subjects having one form of visual acuity loss or the other.

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