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Effects of Reduced Visual Acuity on Academic Performance among Secondary School Students in South-South Nigeria

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Abstract: ***Background:*** ***The eyes play vital role in our lives and are perhaps the most gift we have. Visual perception or vision is the ability to interpret information and surroundings from the effects of visible light reaching the eye.*** ***Materials and Methods:*** ***A descriptive cross sectional study was used that involved the use of data form, for each of the 2 secondary schools and the administration of 360 self administered structured questionnaires to pupils in these secondary schools.*** ***Results:*** ***71.71% of the population studied had normal visual acuity while 28.29% had reduced visual acuity. 57.77% of those with normal visual acuity had good academic performance (≥50% average academic score). While 42.23% of those with normal acuity had poor academic performance (average academic scoreless than 50%). Of the 99 students with reduced visual acuity 42.42% had good academic performance (≥50% average academic score), while 57.58% of those with reduced visual acuity had poor academic score (average <50%).Visual acuity had a significant impact on their academic performance.*** ***Conclusion:*** ***In this study series, we recommend that there should be immediate referral of children with suspected visual problem for proper investigation and treatments. Also school screening programmes should be established and follow up for refractive error involving both preschools and children should be done to avert poor academic performances of children and its sequellae.***

Keywords: reduced 'visual acuity', refractive error," school children, visual screening; vision 2020; visual acuity and academic performance.

1. Introduction

The eyes play vital role in our lives and are perhaps the most gift we have. Visual perception or vision is the ability to interpret information and surroundings from the effects of visible light reaching the eye. Vision is a dynamic process that integrates sensory and motor information generated by the brain and body to derive meaning and direct movement. Vision allows us to take what we see and process it so we can identify what we see by its characters, store information for future retrieval, and integrate the sight information and other senses (touch, hearing, taste and smell) and compare the information with the previously stored information [1].

Visual impairment is any visual condition that impacts an individual's ability to successfully complete the activities of everyday life which include academic activities and other leisure activities such as playing ball, watching television and involvement in other recreational activities. Students with visual impairments are infants, toddlers, children and youths who experience impairments of visual system that impact their ability to learn.

Reduced vision often results in a low motivation to explore the environment, initiate social interaction, and manipulate objects. These students cannot share common visual experiences with their sighted peers, and therefore vision loss may negatively impact the development of appropriate social, skills [2], [3], [4], [5], [6].

The visual acuity demand for a given task depending on the minimum size of the detail in the task and the observer distance. [7] the national of acuity is written as a fraction with normal vision being 6/6. This implies that a person can see details from 6 meters away the same as a person with normal sight would see from 6 meters. [8] Conversely, a 6/60 vision implies that a person can be see details from 6 meters away, a person with normal eyesight will see the same from 60 meters away.

The estimated visual acuity at birth is between 6/60 and 6/120 By 6-9 months, the visual acuity improves rapidly to near normal. By 2 years of age, visual acuity is 6/6 (normal)

It is expected that after 2 years of age an individual should have a normal visual acuity (at least 6/6). Proper development of visual acuity depends on an individual having normal visual input at a very young age. Any visual deprivation, that is, anything interfering with such input over a prolonged period will usually result in a severe and permanent decrease in visual acuity in the affected eye if not treated [9]

In older children, refractive error is a frequent cause of reduced visual acuity. Refractive errors are eye disorders which results due to an error in the focusing of light by the eye. [10] These errors may be due to abnormal curvature of the cornea (astigmatism), too short eyeball axis or weak eye refractive power (myopia) and too long eye ball axis or weak

eye refractive power (myopia). They all result in blurred division and reduced visual acuity. [11]

Children with refractive errors and other visual impairments struggle in school, straining to make out burry images on the board, squinting to see classroom demonstrations and falling behind in everyday tasks like homework. Even leisure activity such as playing ball or watching movies presents difficulties to the child and the child may be labelled as having learning or behaviour problem. [12] Poor vision may even lead to child to drop out of school as a result of chronically poor academic performance. Uncorrected refractive error may not be life threatening but they can be "quality of life threatening" by negatively affecting academic achievement, social adjustment and economic survival [12] Since adequate vision is an important factor in a child's physical, intellectual, social and emotional development, there is need for visual screening. Early detection of visual problems will provide a child a child more opportunity for educational success. Detection of visual problems in children involves the teachers, parents and school health personal. Unusual behaviour, poor school performance and reduced rates of learning may indicate visual problem which require screening and subsequent referral for proper treatment. [13] Visual acuity test is a routine part of an eye examination or general physical examination. [14]

2. Materials and Methods

2.1 Study Area

The study was conducted among students of Foundation Comprehensive College in Aluu with a population of 486 students and Community Secondary School Rumuekini in Rumosi with a population of 1200 students, (private and public schools respectively) both in Ikwere Local Government Area of Rivers State , which has a total number of thirty five (35) public secondary schools. Both are mixed school comprising Junior Secondary (JSS) and Senior Secondary School (SSS). Therefore, there are six levels in school.

2.2 Study population

This consisted of students of foundation Comprehensive College and Community Secondary School. The eligibility criteria were as follow:

Inclusion Criteria

- Student of foundation Comprehensive College and Community Secondary school.
- Students within the age of 11-17 years.

Exclusion Criteria

- Students less than 11 years
- Students greater than 17 years of age.

2.3 Study Design

It was a descriptive cross sectional study of students of Foundation Comprehensive College and Community Secondary School.

2.4 Sampling size Determination

A total number of 360 students were selected from the study population. The sample size was derived thus:

- The population of children with reduced visual acuity as shown from other studies is 30.8%, as referred from a work carried out Kasmann-Keller B and Rupercht K.w in Germany. [15]
- This was taken as our working population. The precision tolerated was set at 5% at 95% confidence interval using the formula:
-

$$n = \frac{pq}{\left(\frac{e}{1.96}\right)^2}$$

Where

n= sample size
p = working proportion = 30.8%
q = 100-p = 100-30.8 = 69.2%
e = margin of sampling error tolerated (5%), at 95% of degree of confidence.

$$n = \frac{30.8 \times 69.2}{\left(\frac{5}{1.96}\right)^2}$$

$$n = \frac{2131.36}{6.51}$$

$$n = 327$$

Attrition rate was taken as 10%. Therefore, adjusting for 10% attrition

$$= \frac{10 \times 327}{100}$$

$$= 32.1$$

$$= 33$$

Hence, adjusted sample size = 327 +33 = 360
Working sample size = 360 students.
School A = Foundation Comprehensive College, Aluu
School B = Community Secondary School Rumuekini Rumosi

The ratio of school A: School B = 1:3
Working sample size of school A = 90 students
Working sample size of school = 270 students

2.5 Sampling Method

A proportionate stratified Radom sampling method was used. Each level represented a stratum i.e. JSS1, JSS2, JSS3, SSS1, SSS2 and SSS3.

Steps

1. Sampling frames were obtained from the study areas. Sampling frames:
   486 = for foundation Comprehensive College, Aluu.
   1200 = for Community Secondary School Rumuekini, Rumosi.
2. The contribution of each stratum (level) to the study population was noted.
   School A: Foundation Comprehensive College, Aluu.

2a. Contribution of each stratum to the study population:

JSSI = 37, 37/486x100/1 = 7.61%
JSS2 = 52, 52/486x100/1 = 10.70%
JSS3 = 75, 75/486x100/1 = 15.43%
SSS1 = 89, 89/486x100/1 = 18.31%
SSS2 = 143, 143/486x100/1 = 29.42%
SSS3 = 90, 90/486x100/1 = 18.52%

3a. The percentage contribution of each level in school A to the sample size was determined.

JSS1 = 7, JSS2 = 10, JSS3 = 14
SSS1 = 16, SSS2 = 26, SSS3 = 17
Total: 7+10+14+16+26+17=90

4a. the subjects were randomly selected using a table of random numbers.

School B: Community Secondary School Rumuekini, Rumosi

2b. Contribution of each stratum to the study population was noted.

JSSI = 250,250/1200 x100/1 = 20.83%
JSS2 = 230,230/1200x100/1 = 19.17%
JSS3 = 203,203/1200x100/1 = 16.92%
SSS1 = 182,182/1200x100/1 = 15.17%
SSS2 = 176,176/1200x100/1 = 14.66%
SSS3 = 159,159/1200x100/1 = 13.25%

3b. the percentage contribution of each level in school B to the sample size was determined.

JSS1 = 56, JSS2 = 52, JSS3 = 46
SSS1 = 41, SSS2 = 40, SSS3 = 35
Total: 56+52+46+41+40+35=270
(Sample size for school B)

4b. the subjects were randomly selected using a table of random numbers.

2.6 Study Instruments

Snellen chart

This is an eye chart used to measure distant visual acuity. The symbols on chart are known as optotypes. The optotypes have the appearance of block letters and are intended to be seen and read as letters. Each line of letters is noted from the top to the bottom respectively;

$$\frac{6}{60}, \frac{3}{36}, \frac{6}{24}, \frac{6}{18}, \frac{6}{12}, \frac{6}{9}, \frac{6}{6}, \frac{6}{5} \text{ and } \frac{6}{4}$$

For this study, a three metre snellen chart was used. (Reverse snellen chart)

Pinhole occlude

The pinhole occlude is an opaque disc with one or more small holes, which is used to test VA. It is a sampling way of focus light, temporarity removing the effects refractive error. Hence, it is used to distinguish visual effects by refractive error, which improves when the pinhole occlude is used from other problems which do not.

Data form

This is a form which consists of the biodata and the result of the screening in each eye. A copy of the data form, questionnaire and the photograph of the instrument is shown in the appendix.

2.7 Questionnaire

The questionnaire consists of 4m parts.

a. The biodata
b. Mean academic scores

2.8 Biodata

This was comprised of age, sex, class and parent's occupation.

2.9 Mean academic score

These were in the range of: 0-30, 40-49, 50-59, 60-69, 70 and above.

2.10 Study Procedure

The principals for the two schools were contacted and an informed consent was obtained after a detailed explanation of the purpose, content and benefit of the study.

The students were also made to understand the essence of the screening and specific conducted in a hall with normal day light lighting. A six meter distance we mapped out and the snellen chart was placed at one end. A seat was placed at the other end of the distance with the back of the seat directly on the sis meter line. The right (R) eye was the let (L) eye with an occlude without pressing tightly. The child was not allowed to squint, tilt-head or close occlude eye.

The child was told to read the letters on the chart from top to the bottom moving across the line from right to left using a pointer. If any student failed to read a line, it was repeated in the reverse order. If the line was failed twice, the visual acuity (VA) is taken as the next higher line read correcting. The procedure was repeated with the right eye occlude. The pinhole was used for children with visual Acuity (VA) less than or equal to 6/9.

For subjects using spectacles, Visual Acuity (VA) with spectacles was tested and recorded. The visual Acuity (VA) was recorded as a fraction where the numerator (top number) represents the distance from the chart while the denominator (bottom number) represents the lowest line read correctly on the chart.

2.11 Data Analysis

Information obtained from the data from and questionnaire used for the screening exercise were analyzed manually by sorting and tallying. Summary statistics, simple frequency, cross tabulations and chi square test computed. The cut off for normal distant visual acuity was taken to be vision of greater than or equal to (6/6, 6/5 or 6/4) using the Snellen chart. Visual acuity of less than or equal to 6/9 (≤6/9) was taken as criteria for reduced visual acuity because WHO

criterion for 1000 vision (VA≤6/18 in the better eye) is already grossly subnormal for school children. The students with refractive error were defined by those whose reduced vision improved with pinhole.

2.12 Study Limitation

1) Some children who were selected declined the test for reason not known.
2) Some children may have pretended not to see some of the letters on the chart.
3) Some children may have memorized the chart which would affect the outcome

3. Result Analysis

3.1 Introduction

The visual acuity of three hundred and fifty students of two schools; community secondary school Rumuckini 260 (74.28%) and Foundation secondary school Aluu (90) (27.7%), were tested. Out of the three hundred and fifty students selected (350). Ten students did not participate in the screening exercise (3 were absent 7 declined). Hence, the response rate was 97.22% and the attrition rate 2.78%. 100% response from Foundation Comprehensive College and 96.15% from Community Secondary School, Rumuekini.

The students tested were between the ages of eleven and seventeen years (11-17) Seventy students (20.00%) were within the ages of 11-12years, one hundred and fifty three students (43.71%) were within the ages of 13-15years and one hundred and twenty seven (36.29%) were within ages of 16-18 years.

Table 1: A table showing the standard deviation of age distribution

Class Interval	*Class mark[x]*	*Absolute freq [f]*	*Relative freq[%]*	*fx*	*x-x-3.5*	*$(x-x)^2$*	*$F(x-x)^2$*
10-12	11	70	20	770	-3.5	12.25	857.5
13-15	14	153	43.71	2142	-0.5	0.25	38.25
16-18	17	127	36.29	2159	2.5	6.25	106.25
total		350		5074			1002

$$\bar{X} = \frac{\sum fx}{\sum f}$$

$$\bar{X} = \frac{5074}{350} = 14.50$$

$$SD = \sqrt{\frac{\sum f(x-x)^2}{n-1}} = 1002 = \sqrt{\frac{1.69}{350}}$$

Mean ±SD=14.50+1.69

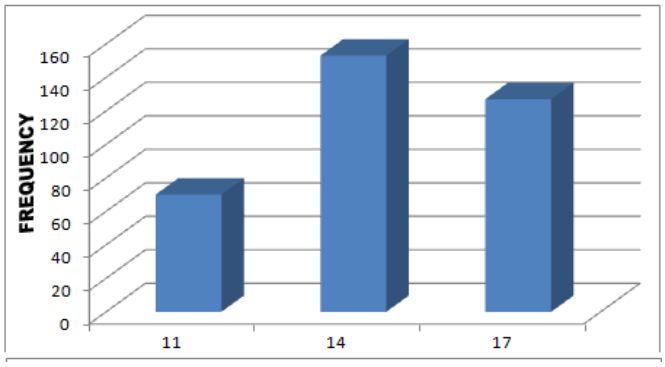

Figure 1: Showing Age Distribution

Among the students tested, there was more females than males. The females were 200 (57.14%), with 40 from foundation and 160 from CSS Rumuekini. One hundred and fifty (42.85% were males, 50 from foundation and Hundred from Rumuekini.

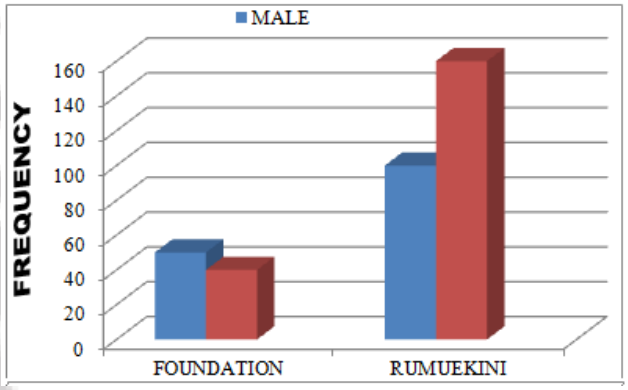

Figure 2: Bar chart showing sex distribction of each school

Of all the students tested, 59 (16.86%) were in JSS1 (foundation 7, Rumuekini 52), 57 (16.29) were in JSS2 (f10, R40), 60(17.14) were in JSS3 (F14, R46),56(16.28%0 were in SSS1 (F16,R40), 60 (17.14%) were in SSS2 (F26, F34), AND 58 (16.57%) were in SSS3 (F17, R41).

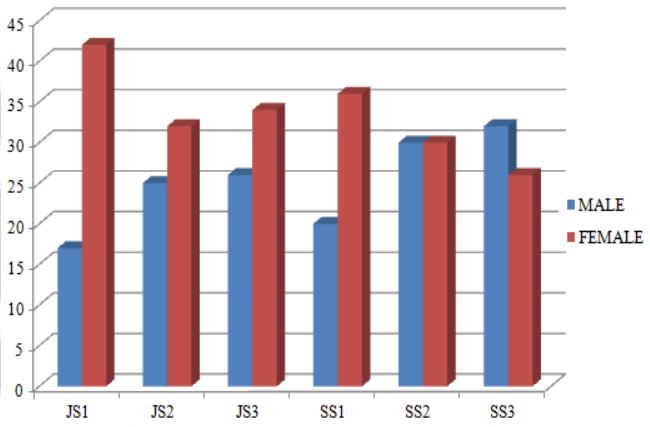

Figure 3: Bar chart showing class-sex distribution of students tested

3.2 Proportion with Normal Visual Acuity

Out of the three hundred and fifty students tested, two hundred and fifty one (71.71%) had a visual acuity of 6/6 or 6/5 or 6/4 in either eye of which 45 (17.92%) were between ages 10-12 (F10, R35), 118 (47.20%) were between ages 13-

15years (F30, R88) and 88 (35.20%) were between ages 16-18 (F28, R60).

Table 2: a table between age distribution and normal vision

Age	*Normal*
10-12	45
13-15	118
16-18	88

3.3 Proportion With Reduced Visual Acuity

A total of Ninety nine (28.28%) students have reduced visual acuity that is visual acuity of 6/9 or worse. Of this number, 29 (29.22%) were within ages 10-12 years (F4, R25), 33 (33.33%) were between ages 13-15 (F6, R27) and (37.37%) students were within ages 16-18 years (F12, R25).

Out of the ninety-nine students with reduced visual acuity fifty-five (55.56%) were females (F12, R43) and forty-four were (44.44% were males (F8, R36%). Out of the ninety-nine students with reduced visual acuity fifty-five (55.55%) were females (F12, R43) and forty-four were males (F8, R36). Out of the ninety-nine students with reduced visual acuity (79.80%) had refractive error (F15, R64) and 20 (20.20%) had visual acuity problem with the macula (F7, R13).

Table 3: A table showing age and reduced visual acuity

Age	*Reduced Visual Acuity*
10-12	29
13-15	33
16-18	37

4. Academic Performance

Of the three hundred and fifty tested, 145 (41.45%) students with normal visual acuity had academic score of ≥50 (50-59=80, 60-69=32≥70=33) that is 41.45% had good academic performance while 106 (30.29%) students had a score of below 50 (0-39-40, 40-49=57) while of the ninety-nine students with reduced visual acuity 42 (42.42%) had scores fifty and above while 57 (57.77%) students had score below 50%.

4.1 The association between visual acuity and school performance

Table 4: A two by two chi-square table to compare the association between visual acuity and academic performance

Visual acuity	*Good*	*Poor*	*Total*
Normal	145	106	251
Reduced	42	57	99
Total	187	163	350

Assuming the null hypothesis ($H_{0)}$ = There's no significant association between the visual acuity of respondents and their academic performance.

H_1=There's significant association between the visual acuity of respondents and their academic performance.

$$= \frac{RT \times CT}{Grand\ total} = \frac{(Row\ total \times column\ total)}{Grand\ total}$$

$X^2_{cal.} \sum (observed\text{-}Expected)^2/expected$
$=0.884+1.015+2.242+2.572$
$X^2_{cal}=6.713$
Degree of freedom $(d_f) = (r-1)(c-1)$
$\alpha = 0.05$ (i.e 5%)
$X^2tab = 3.84$

Since $X^2_{tab} < X^2_{cal,}$ this rejects the null hypothesis which means that there is a significant association between Visual Acuity and Academic performance.

5. Discussion

School screening for uncorrected refractive errors and other eye conditions causing visual impairment has been the subject of many studies during the past years. Its proponents suggest that school vision screening provides an effective way to identify children who require vision therapy, especially glasses. [16]

The results revealed that, of the 350 students, 57.14% were females and 42.86% were males, 20% of the population studied were between 10-12 years, 43.71% were between 13-15 years and 36.29% were between 16-18years.

It was not surprising that of the 350 students tested, 251 students (71.71%) had normal VA. Lopes et al in Brazil showed a high prevalence of 82.9% and 80.2% among children attending public and private schools respectively. [17] While Kasmann-Keller B and Ruprech KW reported a slight lower prevalence to 69.2% among children starting primary school in Saarland Germany. [15] Also, in a study in Southern China among 4364 children aged 5-15 years, a prevalence of 49.49% was recorded. Results of BM Bayoumy equally revealed a lower prevalence of 48.7% (VA≥6/6) among 5839 school children in Cairo Egypt.[18] Similarly, a prevalence of 51.3% (VA≥6/9) was also reported by EL-Bayoumy et al among school children aged 7-14 years in Cairo, Egypt.[19]

Of the 350 students from the two schools, 28.29% had reduced visual acuity and 71.71% had normal visual acuity in one or both eyes. 46.57% of the 350 students had unsatisfactory or poor school performance, while among those with reduced visual acuity only 42.42% had such a performance.

This study found a significant association between visual acuity and academic performance (X^2 calculated = 6.71, X^2 tabulated = 3.84, degree of freedom = 1, P = 0.05, therefore, X^2 tabulated <X^2 calculated). B.O. Adegbehingbe et al in his study in three secondary schools in Osun State, Nigeria revealed that 22.5% of the 1707 adolescent-screening had reduced VA which is similar with the 28.29% 0f students that had reduced visual acuity in our study. [16]

Another study carried out by Gomes-Neto et al among primary school children in North East Brazil, showed that children with compromised vision (less than 90% on the snellen chart), had a 10 percentage point higher probability

of dropping out of school, and 18 percentage point higher probability of repeating a grade and scored about 0.2 to 0.3 standard deviations lower on achievements tests. [20]

In our study 99 (28.29%) of the 350 students selected from two secondary schools had compromised vision (less than 90% on the snellen chart), and 57.58% of those with reduced visual acuity had poor academic performance and a higher probability of repeating the class. Chen-AH et al in his study conducted among 1, 103 school children in 7 public schools in the Klang valley region of Malaysia, showed that children with average and above average achievement showed a different visual performance profile from those with low academic performance. They had statistically better pass in visual acuity tests. So, children with low academic performance are more likely to exhibit problems in visual acuity. [21] Our result showed similar findings.

Furthermore, Sarina Goldstand et al in a study conducted among seventh graders to compare visual and information processing skills between children with and without mild reading and academic problems and examine the visual defects among them. Visual defects where found among 68% of the participants, non-proficient readers had significant poor academic performance and low vision screening scores than the proficient reader [22] This is similar to our findings. Stewart-Brow et al in another study on the relationship between visual impairment and learning using all 10 years old children from England, reported that subjects with amblyopia had lower score on the Brazil ability scores, than children with normal vision.[23] These findings point to the fact that children with low academic performance are more likely to exhibit problems in visual acuity than children with good academic performance. This is in keeping with our findings.

6. Conclusion

In this study series, we recommend that there should be immediate referral of children with suspected visual problem for proper investigation and treatments. Also school screening programmes should be established and follow up for refractive errors involving both preschools and children should be done to avert poor academic performances of children and its sequellae.

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