Effect of Yellow Filters and Corrective Lenses on Academic Performance of Primary School Children with Abnormal Contrast Sensitivity

C. J. Samuel-Nwokeji[1*], N. C. Ikoro[1], E. C. Esenwah[1], A. U. Megwas[1], Y. C. Azuamah[1], N. C. Ibe[1] and U. C. Ogbonna[1]

[1]Department of Optometry, Federal University of Technology, Owerri, Nigeria.

Authors' contributions

This study was carried out in collaboration among the authors. Author CJSN designed, financed, collected data and carried out the statistical analysis of this study. Authors NCI and AUM wrote the protocol. Author ECE wrote the first draft of the manuscript. Authors YCA, NCI and UCO managed the literature searches. All authors read and approved the final manuscript.

Original Research Article

ABSTRACT

Aim: This study compared the effect of yellow filters and corrective lenses on the academic performance of primary school children with abnormal contrast sensitivity.
Study Design: The study employed quantitative study design involving the measurement of variables.
Place and Duration of Study: This study was carried out in Owerri North, Imo State, Nigeria, from February, 2019 to November, 2019.
Methodology: The study included 34 children between 7-12 years old in private and public schools with abnormal contrast sensitivity comprising 7-9 year-olds (64.7%); 10-12 year-olds (35.3%); Males (52.9%) and Females (47.1%). Using basic optometric procedures and Pelli-Robson contrast sensitivity chart, children with abnormal contrast sensitivity were identified for the study. Academic performance was assessed by comparing the previous midterm summative test result (pre-test) with the current midterm summative test result (post-test).
Results: Paired sample t-Test showed no significant difference in academic performance of children using corrective lenses (p = .47), and those using corrective lenses with yellow filters (p =

---

*Corresponding author: E-mail: chiagoziemella@yahoo.com, chiagoziemella@yahoomail.com;

.94) respectively at 95% confidence interval. Also, children using corrective lenses compared with those using corrective lenses with yellow filters showed no significant difference (p =.57) in academic performance. Further, no significant age and gender variation in academic performance was identified (7-9 yrs: p =.38; 10-12 yrs: p =.79; Males: p=.38; Females: p =.79).
Conclusion: Corrective lenses and Corrective lenses with yellow filters had no effect on academic performance of primary school children 7-12 years of age with abnormal contrast sensitivity.

1. INTRODUCTION

Refractive error has been reported to be the most common visual condition that affects school aged children in the developing world [1]. Since children do not usually complain of visual difficulties, early detection and prompt treatment of eye disease is important to prevent vision problems and eye morbidities that could affect their learning ability and adjustment in school [2]. Whereas, uncorrected refractive error has been revealed to be one of the leading causes of poor academic performance of school children as well as social adjustment, corrective lenses have been found to improve academic performance of school children with uncorrected refractive error as well as improve their focus and participation in academic activities [3,4,5].

Contrast sensitivity, defined as the ability to detect the lowest illumination difference between an object and its background is one of the main requisites for good vision. Although, information on visual acuity (VA) of a patient is clinically important in the correction of refractive errors, it does not give absolute information on the visual function of the patient [6]. This is seen in some cases where patients continue to experience visual disturbances in the presence of normal visual acuity as loss of contrast sensitivity has been reported to be more prominent and disturbing to an individual than the loss of visual acuity [7]. Consequently, clinical assessment of contrast sensitivity function and it's improvement in children is valuable in order to support the child and establish an adequate level of functional vision [8].

The use of yellow filters has been reported to significantly improved contrast sensitivity in some ocular conditions that result in abnormal contrast sensitivity function including pathological myopia [9,10,11] as well as spherical aberrations associated with dilated pupils in myopia [12]. However, there is no known data on the effect of corrective lenses with yellow filters on academic performance of primary school children with abnormal contrast sensitivity compared with the traditional clear lens spectacle used in correction of myopia in school children. According to studies, the age of onset of myopia is between 7-16 years of age [13] and in addition to being immediately disadvantageous, the reduction in age of onset of myopia is of great concern [14]. The degree of myopia included in this study was within -0.50D to -2.50 and abnormal contrast sensitivity included in the study was between 1.05 -1.55 log CS.

2. METHODOLOGY

2.1 Study Location

This was a school based study carried out in Owerri North, Imo State which is located in South Eastern Nigeria. Owerri North is made up of 19 autonomous communities and has its administrative headquarters in Orie Uratta. It spans an area of about 198 km^2 [15] and is represented in Fig. 1 [15]. It is a suburban part of the state that is comprised of mainly Igbo ethnic group who are predominantly civil servants with a less population of farmers in the rural regions.

Due to the need to transport the pupils with myopia to the clinic for contrast sensitivity test, two communities (Amakohia and Akwakuma) which composed of 10 public and private schools were purposefully chosen from the existing 19 communities in the local government for this study based on their proximity to the only clinic known to have contrast sensitivity chart within the local government. However four primary schools as study sites were randomly selected from the existing 10 public and private primary schools within these two communities.

2.2 Research Design and Study Duration

This was a cross-sectional study, carried out within the first term of 2019 academic year. During the first stage, permission was sought from the school authorities of the designated schools. Letters requesting for consent were given to each parent and guardian explaining the

nature of the exercise and what was requested of his/her child as well as the benefits of the study. The classroom registers were reviewed and comprehensive lists of the pupils who were 7-12 years old [13] were prepared to enable sampling were prepared to enable sampling, bearing in mind the age of onset of myopia [13]. The second stage involved eye examinations of the participating pupils in order to identify those that met the inclusion criteria for the study, and a review of their previous mid-term summative test results on English language, Mathematics and Native language [16] from their classroom teachers which represented the first phase of the academic performance assessment in the study (Pre-Test) was carried out [17]. The eye examination with basic Optometric equipment was used to identify those with Myopia and they were taken to the clinic the next day for Contrast sensitivity test in other to identify children that

had abnormal contrast sensitivity. Also, during this stage, free corrective lenses and corrective lenses with light yellow filters prescriptions [10] were dispensed to each of the groups of the pupils who had abnormal contrast sensitivity respectively based on reports by previous studies [10,17]. The pupils were allowed to use their lens prescription for approximately 1.5 months before the commencement of the pupil's current term summative test [18]. Finally, the third stage of the study which involved the second phase of academic assessment for the study (Post-Test) was carried out [17].

2.3 Study Population

The study population comprised of 34 primary school pupils within the designated schools who had myopia with abnormal contrast sensitivity and met the inclusion criteria.
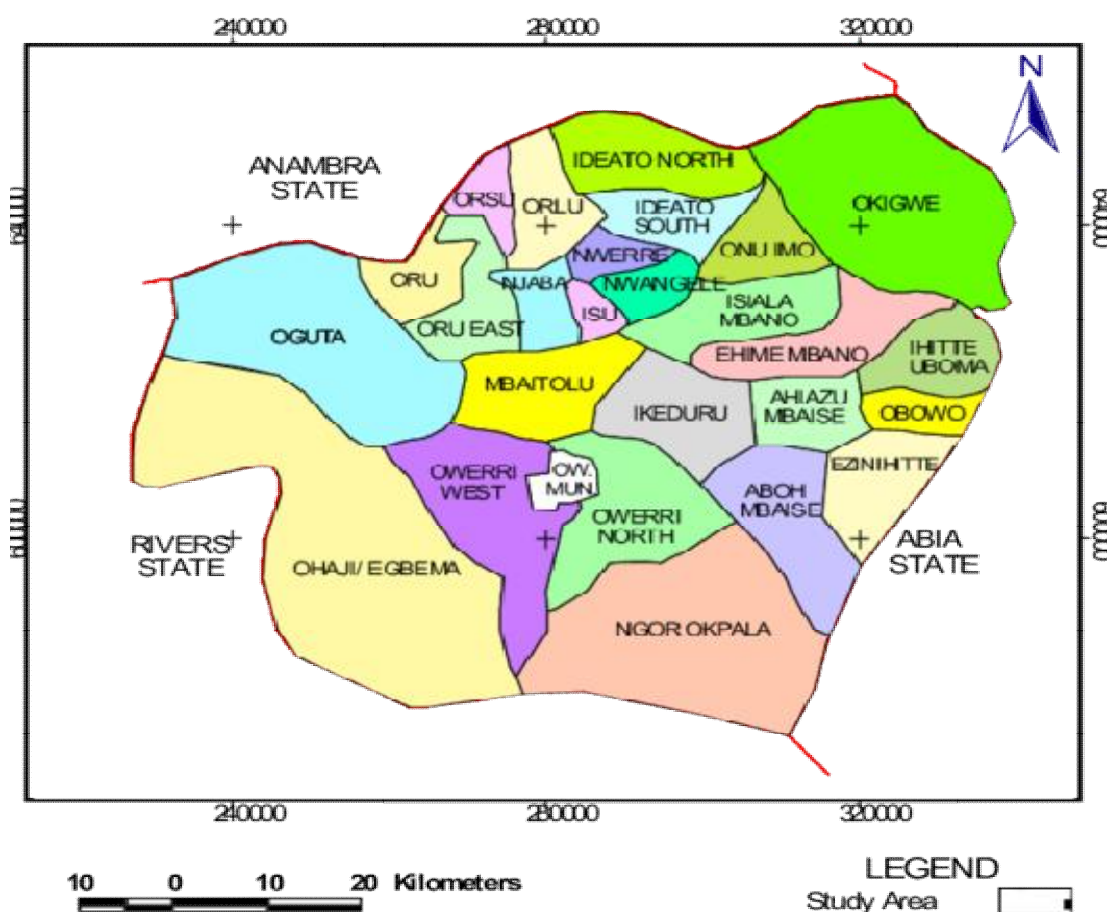

Fig. 1. Map of Owerri showing her local government areas
Source: Ogbuagu and Ayode, (2012)

2.4 Inclusion Criteria

The children considered in the study were:

- Pupils who had myopia with associated abnormal contrast sensitivity
- Pupils whose parents provided informed consent.
- Pupils who were 7-12 years of age.

2.5 Procedure for Data Collection

2.5.1 Case history

Case history was taken by the use of questionnaire through the help of the parents on relevant information such as; name of child, age, sex, and socioeconomic status. Socioeconomic status of the children was determined using the fathers' occupation [19,20,21]. Children whose parents were civil servants and professionals were graded to have high socioeconomic status compared with children whose parents were traders and artisans who were graded as having low socioeconomic status. Questionnaire was also used to gather information on the opinion of the classroom teachers on the effect of the lens correction on each child's classroom academic participation.

2.5.2 Visual acuity

Visual acuity (VA) test was performed outdoors using snellen's Literate wall chart with letter optotypes from 6/60 -6/5 rows or Snellen's illiterate wall chart [22,23,24]. The child was told to read the letters on the chart from top to the bottom. Any row that the child was able to identify correctly all the presented optoypes symbols was recorded as the entry VA for that child [23]. However, the pinhole was presented to any child whose V.A was less than 6/9 in better-seeing eye during the initial testing phase and improvement of visual acuity through the pinhole was termed refractive error [25]. The children who were old spectacle wearers had their VA measured with and without their glasses and those with habitual VA < 6/9 were also refracted.

2.5.3 Direct ophthalmoscopy

A room was made available by each school where some standard optometric tests such as static Retinoscopy and Direct Ophthalmoscopy were performed. Direct Ophthalmoscopy was carried out where indicated (using Keeler ophthalmoscope) to rule out the presence of opacity in the ocular media. During the test, dim illumination was achieved by switching off the light and drawing the curtains. The largest aperture beam was used to get a large field of view of the fundus [26].˙Opthalmoscopy in this study was aimed at detecting the presence or absence of abnormalities such as opacity and not to give specific details or location of the opacity.

2.5.4 Retinoscopy

Static Retinoscopy test was carried out (using Keeler retinoscope) on every child who failed visual acuity test in the study to objectively determine type of ametropia. Dim illumination was also achieved as described in the case of Ophthalmoscopy. During the test, the working distance dioptric equivalence was inserted into the back cell of the trial frame to compensate for the examiners working distance and the eyes were scoped separately for reflex movement. Using a streak reflex, only the children with against movement of equal or negligibly different magnitude of streak were referred for subjective refraction.

2.5.5 Subjective refraction

Children with VA less than 6/9 [27], whose VA improved with Pinhole and who had undergone retinoscopy were further subjected to Subjective Refraction using non cyclopegic refraction approach [28,29,30]. The use of non cycloplegic refraction was to encourage parents and guardians to allow their children and wards to participate in the exercise as well as not to interrupt or negatively influence the children's participation in the school day's academic activities. Spherical equivalence of $\leq$ —0·50 Diopters was defined as myopia [28].

2.5.6 Contrast sensitivity test

Pelli-Robson contrast sensitivity(CS) chart at 1meter was used to measure the contrast sensitivity at low spatial frequency [8] and Pelli-Robson contrast sensitivity value of < 1.65 Log CS was considered abnormal contrast sensitivity result [8,26,31]. During the test, some of the children were asked to stand in order to maintain an eyelevel with the middle of the chart [26] and measurement was taken both monocularly and binocularly. Each test letter identified by the child was scored 0.05 log CS [8] and the sum of the identified number of letters were noted and recorded. Further, contrast sensitivity was measured with trial lenses representing each child's lens prescription while those given yellow

filters were taken back to the clinic the next day for a second phase of contrast sensitivity test using their dispensed corrective lenses with yellow filters. This was done in order to evaluate the influence of Corrective lenses and Corrective lenses with yellow filters on the Academic performance of the children in the study [32,33].

2.6 Procedure for Data Analysis

Data analysis was performed in IBM-SPSS statistics version 23 (SPSS Inc. Chicago, USA) and Paired Sample t-test was used to compare the mean scores of the pre-test and post-test as well as to compare different stages of contrast sensitivity results. Also, to compare the effect of corrective lenses and corrective lenses with yellow filters on academic performance of the children studied. All computations were performed at 5% level of significance and probability value (*p*), and 95% confidence interval was used to assess significant differences.

3. RESULTS AND DISCUSSION

3.1 RESULTS

3.1.1 Comparison of entry and habitual contrast sensitivity values

The Binocular entry CS of the children in the study using Pelli-Robson contrast sensitivity chart (Table1) showed lower mean CS value (1.391 log CS) than the CS measured with Corrective lenses (1.635 log CS), and the difference in the two is statistically significant (*p* =.00, 95% CI = -0.212 to -0.177). The CS value was also significantly higher for children using Corrective lenses with yellow filters (1.728 log CS), compared to the CS value obtained from the Corrective lenses (1.635 log CS) at 5% level (*p* =.02, 95% CI = -0.209 to -0.025).

3.1.2 Academic performance of children using corrective lenses

Using paired sample t-Test, the average academic performance of the children apparently lowered from 16.2 (81.0%) in pre-test to 15.2 (76.1%) in post-test with the use of corrective lenses (Table 2), but the difference between the pre-test and post-test was not significant (*p* = .47, t = 0.767).

3.1.3 Academic performance of children using corrective lenses with yellow filters

With the use of Corrective lenses with yellow filters, the average academic performance of the school children apparently lowered with a narrower margin from 14.66 in pre-test to 14.599 in post-test (Table 3) than was observed with the use of corrective lenses. The difference probably occurred by chance as no evidence of significant difference was found (*p*=.94, t = 0.075).

3.1.4 Comparison of academic performance with the use of corrective lenses and corrective lenses with yellow filters

With the use of corrective lenses, the average academic performance of the children lowered slightly from 16.2 in pre-test to 15.2 in post-test. Also, in the use of Corrective lenses with Yellow filters, the average academic performance was observed to lower with a narrower margin from 14.66 in pre-test to 14.60 in post-test

Table 1. Comparison of entry and habitual contrast sensitivity values among the children using paired sample t-Test

(a) Binocular entry CS and corrective lenses
(b) Corrective lenses and corrective lenses with yellow filters

Comparison of contrast sensitivity (CS)	Mean	Std. Dev	Std. Error	95% CI Lower	Upper	T	p-value
a. Binocular Entry CS and CS with corrective lenses							
Binocular entry CS	1.391	0.131	0.032				
CS Using corrective Lenses Only	1.635	0.151	0.037				
Difference	-0.244	0.131	0.032	-0.312	-0.177	-7.686	< .00*
b. Corrective lenses and corrective lenses with yellow filters							
CS Using Corrective Lenses Only	1.635	0.151	0.037				
CS Using Corrective Lenses with Yellow filters	1.728	0.100	0.033				
Difference	-0.117	0.120	0.040	-0.209	-0.025	-2.919	.02*

Table 2. Comparison of the mean pre-test and post-test scores of the study population before and after the use of corrective Lenses using paired sample t-Test

Academic performance	Mean	Std. Dev	Std. error	Lower	Upper	T	p value
Corrective lens							
Pretest (%)	16.21	2.71	5.09				
Posttest (%)	15.20	3.83	7.23				
Difference	1.01		6.50	-10.361	20.361	0.767	.47

(Table 4) than with Corrective lenses. The difference in academic performance as a result of the two lenses probably occurred by chance as no evidence of significant difference was found (p =.57, 95% CI = -4.47 to 2.56).

3.1.5 Determination of any age variation in academic performance

At age 7-9, shown in Table 5 , both pre-test and post-test performances between the children who used Corrective lenses (pre-test = 15.8, post-test= 12.9) and those who used corrective lenses with yellow filters (pre-test = 15.9, post-test= 14.4) appeared comparable. The average scores were apparently lower in post-test than in pre-test with a wider margin observed in children using corrective lenses than those using Corrective lenses with Yellow filters, but, no significant difference in academic performance was found (p= .38, 95% CI = -4.98 to 2.07). Similarly no significant difference was found in the academic performance for the 10 -12 years old based on corrective lenses and corrective lenses with yellow filters (p = .79, 95% CI = -6.472 to 5.272). However, the mean academic performance apparently improved from 16.9 to 19.1 for pre-test and post-test respectively with Corrective lenses and from 12.2 in pre-test to 15.0 in post-test with corrective lenses with yellow filters.

3.1.6 Determination of any gender variation in academic performance

Among the male children using corrective lenses (Table 6), the academic performance was rather lower at post-test (14.9) compared to pre-test (16.6) but the change in academic performance was comparatively with a minimal value for the children corrected with corrective lenses with yellow filters (pre-test=16.3; post-test= 16.4). However, there was no evidence of significant difference in academic performance for the males irrespective of the type of lens correction (p =.38, 95% CI = -4.98 to 2.07).

Among the female pupils, similarly no significant difference was found in the academic performance of children using corrective lenses and those with corrective lenses with yellow filters (p = 0.7907, 95% CI = -6.472 to 5.272). The change in academic performances at pre-test and post-test were quite close in both the corrective lenses (pre-test = 15.8, post-test =15.5) and the corrective lenses with yellow filters (pre-test = 12.7, post-test =12.4).

Table 3. Comparison of the mean pre-test and post-test scores of the study population before and after the use of corrective lenses with yellow filters using paired sample t-test

Academic performance	Mean	Std. Dev	Std. Error	Lower	Upper	T	p value
Corrective lens with yellow filters							
Pretest (%)	14.66	4.08	7.18				
Posttest (%)	14.59	3.09	5.43				
Difference	0.07		5.21	-11.626	12.403	0.075	.94

Table 4. Comparison of the mean pre-test and post-test scores of the study population before and after the use of corrective Lenses and corrective lenses with Yellow filters using paired sample t-Test

Lens	Pre-test	Post-test	Posttest-pretest	95% CI			
	Mean (s.d)	Mean (s.d)	Mean (s.d)	Lower	Upper	T	p value
Corrective lenses	16.21 (2.90)	15.2 (4.09	-1.01 (3.68)				
Corrective lenses with Yellow filters	14.66 (4.32)	14.6 (3,26)	-0.06 (3.120				
Difference			-0.96	-4.47	2.56	0.5803	.57

Table 5. Analysis for age variation in academic performance of the study population after the use of corrective lenses and corrective lenses with yellow filters using the paired sample t-test

Age in years	Pre-test	Post-test	Posttest-pretest	95% CI			
	Mean (s.d)	Mean (s.d)	Mean (s.d)	Lower	Upper	T	p value
Age :7-9							
Corrective lens	15.8 (3.38)	12.9 (3.35)	-2.94 (3.23)				
Corrective lens with Yellow filters	15.9 (3.01)	14.4 (3.50)	-1.48 (1.90)				
Difference			-1.46	-4.98	2.07	0.934	.38
Age :10-12							
Corrective lens (White)	16.9 (2.30)	19.1 (1.01)	2.20 (1.31)				
Corrective lens with Yellow filters	12.2 (6.20)	15.0 (3.40)	2.80 (3.42)				
Difference			-0.60	-6.472	5.272	0.284	.79

Table 6. Analysis for gender variation in academic performance of the study population before and after the use of corrective lenses and corrective lenses with yellow filters using paired sample t-test

Gender	Pre-test	Post-test	posttest-pretest	95% CI			
	Mean (s.d)	Mean (s.d)	Mean (s.d)	Lower	Upper	T	p value
Male							
Corrective lens	16.6 (1.98)	14.9 (2.88)	-1.70 (4.32)				
Corrective lens with Yellow filters	16.3 (2.51)	16.4 (3.19)	0.10 (1.39)				
Difference			-1.48 (1.90)	-4.98	2.07	0.934	.38
Female							
Corrective lens	15.8 (3.91)	15.5 (1.18)	-0.33 (3.41)				
Corrective lens with Yellow filters	12.7 (5.62)	12.4 (1.62)	-0.30 (4.83)				
Difference			-0.60	-6.472	5.272	0.284	.79

3.2 Discussion

During the course of the study, the mean Binocular CS with corrective lenses (1.635 log CS) at low spatial frequencies measured with Pelli-Robson contrast sensitivity chart was significantly higher (*p*= .00) than the mean Binocular entry CS of the studied children (1.391 log CS) as seen in (Table 1). This is nevertheless in agreement with the report on CS measurements gotten by new precision metrics in a study by Dorr, et al. [32], where CS taken with optical correction proved to be significantly higher than the CS taken without optical correction among adults with myopia within the ages of 18-75 years old. However, subjecting the same adults (18-75 year-olds) to CS test using Pelli-Robson CS chart according to the study, revealed no significant change between CS measured with optical correction and that obtained without optical correction at refractive errors lower than -3.00Ds [26,32]. This contrary report with Pelli-Robson CS chart to the finding of the current study could be as a result of difference in age between the studied populations and the use of small sample size in the current study. Whereas, this study was among children (7-12 year-olds), and dominated by7-9 year-olds [34], the previous study was among adult population (18-75 year-olds).

Also, CS values measured with corrective lenses with yellow filters proved to besignificantly higher (*p*=.02) with (1.728 log CS) than CS measured with corrective lenses (1.635 log CS) in Table (1). This is also in consonance with works done by Yoshimitsu, et al. [10] which confirmed that yellow filters significantly improve contrast sensitivity.

This study (Table 2), did not identify any significant difference in the academic performance of the children with corrective lenses before and after the use of glasses (pre-test=81.04% and post-test=76.05% ; *p*=.47). This report relates to the finding of related previous work by Dirani, et al. [16] which used the same academic assessment protocol (Maths, English and Mother tongue) as the current study. According to them, distance visual acuity was found not to play a role in determining academic performance among 9-10 year-olds with myopia. However contrary to this, Ovenseri and Assien [29] and Kotingo, et al. [3] in their studies in Ghana and South –South Nigeria respectively reported that uncorrected refractive error was found to have appreciable impact on academic achievements of school children. Also, a study by Lamoureux, et al. [35] and previous studies [17,36,18] on impact of corrective lenses on academic performance of primary school children reported improvement in participation in daily activities and academic achievement with the use of corrective lenses.

However, this contrary report of some of the previous studies from this current study might have emerged as a result of difference in the duration of spectacle use before post-test assessment among the studies, which was approximately 1.5 months for this study [18], compared with the studies by Prema [17], and Joseph [36] who reported improvement in academic performance among children with myopia within 5 and 7 months of spectacle wear respectively. In the study by Glewwe, et al. [18], spectacles were dispensed at different periods to the children (1.5, 3.0 and 6.5 months) before post- test result was assessed and they observed that those with longer period of spectacle wear before post-test assessment had better academic achievements than those with shorter periods of spectacle wear. According to Glewwe, et al. [18], wearing glasses for a longer period leads to an additional acquisition of human capital that reflects as higher test scores among primary school children. Moreso, different methods of assessment of academic performance by the different studies seen in the studies of Joseph [36] and Glewwe, et al. [18] may have also played a role as well as difference in socioeconomic status of the children studied. According to previous studies [18,29,21], improvement in academic performance of children due to corrective lenses was observed mainly among the economically disadvantaged children indicated by type of school and their fathers' occupation.

Hannum and Zhang [21], in their study, reported a correlation between wearing of glasses and improvement in academic performance and according to them, high socioeconomic status was associated with group of children not likely to wear glasses, hence, show no improvement in academic performance. Consequently the dominance of the present study by children of high socioeconomic status (76.5%) might have led to no significant difference in academic performance observed among those using corrective lenses. Also, whereas previous known studies were among the general population of children with myopia [16,17,36], and all the forms of refractive errors [29,18], the current study was specifically among children with myopia and abnormal contrast sensitivity and no known study have reported the effect of corrective lenses on academic performance of this population of children.

The current study did not identify any significant difference in the academic performance of the **c**hildren using corrective lenses with yellow filters (Table 3) before and after use of spectacle (pre-test = 14.66 and post-test=14.59; *p* = .94). Although, no known previous study has determined effect of Yellow filters on academic performance of children, Yellow filters have been reported to enhance retinal image thereby improving visual quality [37,38]. This was observed in this study as an ordered pattern of apparent improvement in academic performance from the value obtained among those using Corrective lenses for each parameter studied. However, yellow filters has also, been reported to result in moderate colour confusion in yellow and blue colours among users whereby an individual may not be able to perceive yellow and blue colour shades properly [37] and this may have hindered its impact in the existing human capital and hence academic achievements [18] among the studied children.

This work did not identify any significant difference in academic performance of the children using Corrective lenses when compared with the academic performance of the children using Corrective lenses with Yellow filters in Table 4 (*p* =.57). The absence of significant difference between academic performance of those with Corrective lenses and those with Corrective lenses with yellow filters may have arisen from the fact that though, Yellow filters

have been reported to improve clarity of vision, it did not seemed to improve human capital development identified to be associated with use of Corrective lenses among primary school children.

No age variation was observed in the study as there was no significant difference in the academic performance of 7-9 years old children corrected with corrective lenses (pre-test score =15.8 and post-test score=12.9) and those using Corrective lenses with Yellow filters (pre-test score=15.9 and post-test score =14.4) as shown in Table 5, at p = .38. Although, 10-12 years-olds showed apparent improvement in academic performance with both Corrective lenses and Corrective lenses with yellow filters (pre-test=16.9; post-test=19.1 and pre-test=12.2 and post-test=15.0) respectively, no significant difference was observed in their academic performance at p = .79.

The apparent decline in the overall academic performance with the use of Corrective lenses and Corrective lenses with Yellow filters observed among the 7-9 age group compared to 10-12 age group in this study may have been as a result of difference in the level of learning between the study populations. While 7-9 year-olds are usually found in lower classes of learning, 10-12 year-olds usually belong to higher level classes which involves more academic work. According to studies by Dirani, et al. [16] and others, children in higher level of learning tend to have higher academic achievements compared to those in lower levels.

Also, it may be as a result of decline in academic performance reported to be associated with any form of transition among primary school children during academic years which also was found to be apparently associated with younger age [39]. Since the study was carried out in the first term, the presentation of new set of class work and adjusting to new set of friends especially among the younger age group may have played a role in the apparent reduction in academic performance. However, the result of this study among the 10-12 age group did not agree with the finding of previous studies [18,17,36] which reported significant improvement in academic performance among 10-12 years old primary school children with poor vision with the use of corrective lenses respectively.

This might have been as a result of shorter duration of spectacle wear in this study compared to the previous studies [18,17,36].

Finally, the result obtained in this study (Table 6) did not identify any significant difference in academic performance between the males using Corrective lenses and Corrective lenses with yellow filters (pre-test=16.6 and post-test=14.9; pre-test=16.3 and post-test=16.4) respectively at p = .38.

Also, females using Corrective lenses did not show any significant difference in academic performance from those using Corrective lenses with Yellow filters (pre-test=15.8 and post-test=15.5; pre-test=12.7 and post-test= 12.4) respectively at p = .79 (Table 6). This is in agreement with a related study by Glewwe, et al. [18] which reported no gender variation in academic performance among 10-11years old children corrected with corrective lenses. This might have been as a result of similarities in the anatomical and psychological nature of the children which have been reported to experience changes from teen age. Based on Rudnicka, et al. [40], study; younger age population are unlikely to show any gender difference in studies.

4. CONCLUSION

During the course of the study, it was observed that Corrective lenses with Yellow filters improved abnormal contrast sensitivity at low spatial frequency among 7-12 years old primary school children but the improvement did not culminate into significant higher gains in academic performance but led to apparent improvement in academic performance among the children in this study. It was also observed that corrective lenses improved contrast sensitivity significantly among the studied population though to a lesser extent than corrective lenses with yellow filters. After 1.5 months of lens correction, this study was able to establish that, Corrective lenses and Corrective lenses with Yellow filters did not have significant effect on the academic performance of the studied 7-12 years old primary school children with abnormal contrast sensitivity.

It is recommended that further studies should be carried out on the effect of duration of lens correction on academic performance of primary school children.

5. LIMITATIONS OF STUDY

(1) Lack of discipline over lens wear during academic activities among the children.
(2) The age groups were not equally distributed rather 7-9 year-olds dominated the study population.

(3) Due to time constraint based on the peculiarity of the study population (school children), the duration of lens wear was comparatively short in this study.

CONSENT

Authors declare that informed consent was obtained from each participant for the publication of this study.

ETHICAL APPROVAL

All authors hereby declare that all experiments have been examined and approved by the Ethical Committee of School of Health Technology, Federal University of Technology, Owerri.

ACKNOWLEDGEMENTS

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Ma X, Congdon N, Yi H, Zhou Z, Pang X, Meltzer M, et al. Safety of spectacles for children's vision: A cluster Randomized Controlled Trial. Am. J. Ophthalmol. 2015;160(5):897–904.
2. Opubiri I, Pedro C. Screening for refractive error among primary school children in Bayelsa State, Nigeria. The Pan African Med. J. 2013;14:74–76.
3. Kotingo E, Obodo D, Iroka F, Ebeigbe E, Amakiri T. Effects of reduced visual acuity on academic performance among secondary school students in south – south Nigeria. Int. J. SC and Res. 2014; 3(4):328–334.
4. Nastaran S, Hussein M, Mohammad K, Ibrahim J. Comparison of quality of life between myopic patients with spectacles and contact lenses and patients who have undergone refractive surgery. J. Curr. Ophthalmol. 2015;27(2):32–36.
5. Dudovitz R, Izadpanah N, Slusser W. Parent teacher and student Perspectives on how corrective lenses improve child wellbeing and school function. Marten. Child Health J. 2016;20(5):974–983.
6. Anstice N, Thompson B. The measurement of visual acuity in children: An evidence – based update. Clin Exp Optom. 2014;97:3–11.
7. Leat S, Yadar N, Irving. Development of visual acuity and contrast sensitivity in children. J. Optom. 2009;2(1):19–26.
8. Milling A, O'Connor A, Newsham D. The importance of contrast sensitivity testing in children. Br IrOrthopt J. 2014;11:9–14.
9. Hammond B. The visual effects of intrao-cular colored filters. Scientifica. 2012;1–18.
10. Yoshimitsu K, Shigeki M, Kazuhiro A. Effect of yellow – tinted lenses on visual attributes related to sports activities. J. Hum. Kinet. 2013;36:27–36.
11. Ahmad A, Sughra U, Muhammad H, Muhammad I. Contrast sensitivity improve-ment with yellow filter in low vision patients. Isla. Med. 2017;9(6):402–405.
12. Karatepe A, Suheyla K, Egrilmez S. Factors affecting contrast sensitivity in healthy individuals: A pilot study. Turk. J. Ophthalmol. 2017;47(2):80–84.
13. Ikoro NC. The aging eye. Functional changes from cradle to gray: A review. J. Niger. Optom. 2010;16:6-9.
14. Holden B, Sankaridurg P, Smith E, Aller T, Jong M, He M. Myopia, an underrated global challenge to vision: Where the current data takes us on myopia control. Eye (Lond). 2014;142–146.
15. Ogbuagu D, Ayoade M. Presence of levels of common polynuclear Aromatic Hydro-carbon (PAHS) in staple Foods of Nigerians. Food and Public Health. 2012; 2(1):50–54.
16. Dirani M, Zhang X, Goh L, Young T, Lee P, Saw S. The role of vision in Academic School Performance. Ophthalmic Epidemiol. 2010;17(1):8–24.
17. Prema N. Impact of Myopia correction on Academic achievement of V11 std students. Int. J. Scientific Research. 2013; 2(8):2277- 8179.
18. Glewwe P, West K, Lee J. The impact of providing vision screening and free eye glasses on academic outcomes. Evidence from Randomized Trial in Title Elementary schools in Florida. J. Policy Anal Manage. 2018;37(2):265-300.
19. Saad A, El–Bayoumy. Environmental risk factors for refractive error among Egyptian

school children. East Mediterr. Health. J. 2007;13(4):819–828.

20. Guo Y, Juan L, Xu L, Tang P, Yun Y, Feng Y, et al. Myopic shift and outdoor Activity among primary school children: One – Year Follow – up study in Beijing. Plos One. 2013;8(9):e75260.

21. Hannum E, Zhang Y. Poverty and proximate barriers to learning, vision deficiencies, vision correction and educational outcomes in rural northwest china. World Dev. 2012;40(9):1921-1931.

22. Lennie P, Van H. Assessment of vision in infants and children: Visual Impairments. Proc. Nat. Acad. Sci. U.S.A. 2002;4:28-89.

23. Ogbonnaya O, Okoyo O, Ezeanosike E. Prevalence of refractive errors in primary school children in a rural community in Ebonyi State of Nigeria. Int. J. Med. Health. Dev. 2013;18(2):1–10.

24. Ingrid M, Wanda J, Rekha H. A review of vision screening method in children. Afr Vis Eye Health. 2018;77(1):2413-2421.

25. Verweyen P. Measuring vision in children. Community Eye Health. 2004;17(50):27–29.

26. Elliot BD. Pelli – robson contrast sensitivity. Clinical Procedures in primary Eye Care. 4th ed. London: Elsevier Health Sciences; 2013.

27. Donahue S, Baker C. Procedures for the evaluation of the visual system by Pediatricians. Am. Acad of Pediatrics. 2016;137:1-11.

28. Manny R, Hussein M, Scheiman M, Kurtz D, Niemann K, Zinzer K. Tropicamide (1%): An effective Cycloplegic agent for Myopic children. Investigative Oph. & Vis. Science. 2001;42(8):1728–1735.

29. Ovenseri G, Assien R. Refractive error in School Children in Agona Swedru, Ghana. S. Afri. Optom. 2010;69(2):86-92.

30. Morgan I, Iribarren R, Fotouhi A, Arzybowski A. Cycloplegic refraction is the gold standard for epidemiological studies. Acta Ophthalmol. 2015;93:581 585.

31. Hargadon D, Wood J, Twelker J, Harvey E. Dobson V. Recognition acuity, grating acuity, contrast sensitivity and visual fields in 6–year –old children. Arch Ophthalmol. 2010;128(I):70–74.

32. Dorr M, Elze T, Wang H, Lu Z, Bex P, Lesmes L. New precision Metrics for contrast Sensitivity Testing. IEEE J. Biomed, Health. 2018;22(3):919–926.

33. Resnikoff S, Pascolini D, Mariotti S, Pokharel G. Global magnitude of visual impairment caused by uncorrected refractive error. Bull World Health Organ. 2008;86:1–80.

34. Faderin MA, Ajaiyeoba AI. Refractive errors in primary school children in Nigeria. Niger J Ophthalmol. 2001;9(1):10-14.

35. Lamoureux E, Saw, Thumboo J, Wee H, Aung T, Mitchel P, Wong T. The impact of corrected and uncorrected refractive error on visual function: The singapore malay eye study. Investig. Ophthalmol. Vis. Sci. 2009;50:2614–2620.

36. Joseph L. Refractive errors and academic achievement of primary school children. Nurs. J. India. 2014;105(6):269-71.

37. Edwards KH. Intraocular lens short wavelength light filtering. Clin. Exp. Optom. 2010;93(6):390-399.

38. Zhao H, Jiang J, Yu J, Xu H. Role of short wavelength filtering lenses in delaying myopia progression and amelioration of asthenopia in juveniles. Int. J. Ophthalmol. 2017;10(8):1261–1267.

39. McGee C, Ward R, Gibbons J, Harlow A. Transition to secondary school. A literature review to the Ministry of Education New Zealand. Waikato Inst Res Curr. 2003;1-70.

40. Rudnicka A, Kapetanakis V, Wathern A, Logan N, Gilmartin R, Whincup et al. Global variations and time trends in the prevalence of childhood myopia, a systematic review and quantitative meta-analysis: Implications for aetiology and early prevention. Br J Ophthalmol. 2016; 100(7):882–890.