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Assessment of the Effect of Blue Light on Visual Acuity among College Students[1]

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ABSTRACT

Visual acuity is the acuteness or clarity of vision which is dependent on the shortness of the retinal focus within the eye, and the sensitivity of the interpretative faculty of the brain. It is expressed as a fraction, such as 20/20 or 6/6 which is the normal visual acuity. Poor or impaired visual acuity is expressed as 20/40 and below or 6/9 and below. Blue light, which is one of the visible rays from the sun and also an artificial constituent of many modern devices, is a source of illumination which among other factors strongly affects our visual acuity. The present rapid, steady advancement in technology has led to a great increase in our usage and exposure to blue light. It is not uncommon nowadays to easily find someone who spends his entire day on digital screen, and many times even a great deal of the nighttime is also spent on blue-light-emitting technologies. The aim of this study is to assess and determine how this blue light affects college students and perhaps their productivity. A descriptive cross-sectional study was conducted using the focus group discussion (FGD) technique amongst 100 college students across five departments in College of Health Sciences, Nnamdi Azikiwe University, Nnewi Campus. The mean age of the respondents was 22.06 years. More of the respondents were females (66%) while 34% were males. The prevalence of visual acuity impairment after a considerably long usage of blue light was 37%. The majority of the respondents (87%) use a light-emitting diode (LED) technology torch/lantern during their night studies. 82% also uses their mobile phones for their studies and other academic works in which they have to spend many hours at once on the screen. Many others are exposed to other sources of blue light, and more even combine usage of different sources of blue light at once. The prevalence of visual acuity status below 6/6 amongst the students was high, and this is worrisome with regards to its long term effects or cumulative effects on their vision. Adequate sensitization on the harmful effects of long exposure to blue lights, usage of blue light filters/glasses (photochromic lens, for instance), taking frequent breaks from digital screens, encouraging outdoor use of blue light screens, early and proper management of impaired vision and more intakes of foods that enhance eyesight are recommended.

Keywords: *Visual acuity; Blue light; Visible rays; Light-emitting diode (LED) technology; College students; Photochromic lens*

INTRODUCTION

The World Health Organization (WHO) in 2018, noted that globally 314 million people were visually impaired, out of which 45 million people were blind and 269 people live with low vision; with about 90% of these visually impaired living in developing countries. A study done during the COVID-19 lockdown showed that there is a drastic increase in use of digital devices, and a slow deterioration of ocular health across all age groups.[1] And according to the American Optometric Association, as little as two hours of continuous digital usage per day is enough to bring about the development of an array of eye and vision related problems. Furthermore, a vision survey done among medical students in 2016 reported a high prevalence of visual deficits among them which

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negatively impacts their learning and performance.[2] Prolonged usage of these devices is not only a stressor on the visual system but also causes musculoskeletal strain and circadian disturbances.[3] The Nigerian national blindness and visual impairment survey in 2007 estimated that 1,092,028 Nigerians (0.78%) are visually impaired.[4]

The human eye is one of the body's special senses and about 90% of human activities are dependent directly or indirectly on visual perception. Vision is the process of seeing something, interpreting what have been seen, gaining meaning, understanding and integrating what have been seen with the information also received. Visual information informs and drives our day to day communications, social interaction, and work productivity. Loss of eyesight or visually impaired workers affect job productivity and also a worker's ability to keep a job, thus, vision is very important in various facets of human existence and occupation.[5]

Vision is a vital physiologic parameter of ocular health. Traditionally, visual function is tested as visual acuity (capacity to discriminate fine details of objects) and visual field (proportion of space in which objects are visible at the same moment during steady fixation of gaze in one direction). Colour vision, flicker sensitivity, contrast sensitivity, pupillary responses and motion testing are some of the other methods of quantitating vision.[6,7] Visual acuity test is a measure of central vision; a measure of sharpness of vision; and an assessment of total visual system from cornea to the occipital cortex. Visual acuity (V.A.) can be tested for both distant (far) and near vision.[8]

In recent years, people have become increasingly attentive to the light pollution influences on their eyes. In the visible spectrum, short-wave blue light with wavelength between 415nm and 455nm is closely related to eye light damage. This high energy blue light passes through the cornea and lens to the retina causing diseases such as dry eye, cataract, age-related macular degeneration, even stimulating the brain, inhibiting melatonin secretion, and enhancing adrenocortical hormone production, which will destroy the hormonal balance and directly affect sleep quality.[9]

There is an increasing rate of usage of many modern devices that emit blue light, and this light is a very high energy light ray which can be harmful to eyesight if not properly managed. More and more students continue to depend on these potentially harmful light sources for their studies and almost all their academic activities. If such dependence causes a decline in their visual acuity, then there could be a high risk of eye defects following the long term use of these devices.

Drawing insight from occupational eye defects, for instance: Occupational eye defects are major contributors to the statistics of visual impairment (low vision and blindness) and a leading cause of monocular blindness (blindness in one eye) not just in Nigeria alone but across the world.[10] Studies have shown that lack of protective equipment, workers negligence and unsafe work environment are some of the major causes of occupational health problems and that an overwhelming majority of workers in Nigeria industry do not wear protective eye devices.[11]

If, then, the users of these blue-light-emitting devices do not also use protective devices or apply similar or other safety measures to prevent the harmful rays from penetrating into their eyes, there will be a high rate of eye defects among these users and especially among college students who depend almost totally on these lights for their studies. The effect of blue light rays on ocular health has therefore become an important concern for the future.

In view of the importance of good vision, this study concentrates on evaluating the effects of blue lights on the status of vision (Visual Acuity) and creating awareness for the safe use of blue-light-emitting devices among college students in College of Health Sciences, Nnamdi Azikiwe University, Nnewi Campus, Nigeria.

MATERIALS AND METHODS

Materials

A Snellen's chart, an occluder, a measuring tape, writing materials

Study Area

The study was conducted in the College of Health Sciences, Nnamdi Azikiwe University, Nnewi Campus. It is situated in Okofia; one of the villages that make up Nnewi North Local Government Area. Its latitude is 5° 58' 26" North and its longitude 6° 53' 32" East.[12] Nnewi has an estimated population of three hundred and ninety-one thousand, two hundred and twenty-seven people (391, 227) according to the Nigerian population census (2006). The city spans over 1,076.9 square miles (2,789 km^2) in Anambra State.[13]

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Research Design

A descriptive cross-sectional study was conducted using the focus group discussion (FGD) technique amongst 100 college students across five departments in the college. Sample population was selected by simple random sampling across the five departments. Their visual acuity were all tested after they have had a prolonged use of any of the sources of blue light; most especially after an all-night study using a smartphone, tablet or laptop.

Inclusion Criteria

The inclusion criteria for this study were:

College students who have no history of any eye defect or eye disease.

Subjects must have had a prolonged use of a blue-light-emitting device.

Exclusion Criteria

The exclusion criterion was:

College students who have eye defects.

Ethical Consideration

Ethical approval was obtained from the Ethical Research Committee of Faculty of Basic Medical Sciences, Nnamdi Azikiwe University. The subjects as well gave their voluntary consents before participating in the study after the details of the study were thoroughly explained to them. No coaxing or incentive methods were used.

Population of Study

A total population of 100 college students was tested for visual acuity immediately after a prolonged usage of a blue-light-emitting device.

Experimental Procedure for Data Collection

The tests were conducted in an outdoor space to ensure a well-lighted environment. The Snellen's chart was hung 2meters high on a wall and a distance of 6meters was measured using the measuring tape between the sitting position of the subjects and the position of the Snellen's chart.

First, for each subject, the left eye was occluded and was asked to read the letters as pointed with their right eye. All the letters were made visible even when the letters were being pointed by a ruler, and the Snellen's chart was prevented from the rays of the sun reflection. Then, after reading the letters with their right eye, same procedure was repeated while occluding the right eye. Afterwards, the subjects were asked to read the letters with both eyes open. During each reading, the subject was asked to pronounce the letters they saw and the records were accurately taken using the writing materials.

Statistical Analysis

Data collected were coded for entry into and analyzed with the Statistical Package for Social Sciences (SPSS) version 21.0 (SPSS, Inc., Chicago, IL, USA). Descriptive statistics of mean, standard deviation and frequency were employed.

RESULT

A total of 100 students were examined from across five (5) departments. Their age range was 18 to 26 years, with mean age of 22.06 years. There were 34 males and 66 females with a male to female ratio of about 1:2. Table 1 shows the socio-demographic variables of the objects. 20 students with no previous history of eye defect were specially selected from each of the 5 departments to participate in the study.

Table 1: Socio-Demographic Variables of Subjects

Parameter	**Frequency**	**Percentage**
AGE GROUP		
18-20	26	26.0
21-23	46	46.0
24-26	28	28.0
• Mean age = 22.06 years		
SEX		
Male	34	34.0
Female	66	66.0
LEVEL OF STUDY		
200L	54	54.0
300L	27	27.0
400L	11	11.0
500L	8	8.0
DEPARTMENTS		
HUMAN PHYSIOLOGY	20	20.0
ANATOMY	20	20.0
NURSING SCIENCE	20	20.0
MEDICAL RADIOGRAPHY	20	20.0
MEDICAL LABORATORY SCIENCE	20	20.0
TOTAL	100	100%

Table 2: Visual Acuity Results of Left Eye, Right Eye and Both Eyes of Subjects

Parameter	**Frequency**	**Percentage**
VA on Left Eye		
6/6 and better	68	68.0
6/9 and below	32	32.0
VA on Right Eye		
6/6 and better	61	61.0
6/9 and below	39	39.0
VA on both eyes		
6/6 and better	63	63.0
6/9 and below	37	37.0
Total	**100**	**100%**

- L = Level
- 6/6 and better = normal visual acuity
- 6/9 and below = poor or impaired visual acuity

Table 2 presents the visual acuity results of the subjects for the tests on the left eye, the right eye, and on both eyes. 68% of the subjects had normal visual acuity (6/6) on both eyes while 32% showed poor visual acuity (6/9 and below) immediately after a prolonged exposure to blue light. For each of the eyes, 61% had normal visual acuity on the right eye and 39% had poor visual acuity; while 63% had normal visual acuity on the left eye and 37% showed a poor visual acuity. A distribution of the common sources of artificial blue light among the students and the frequency of their usage is shown in Figure below.

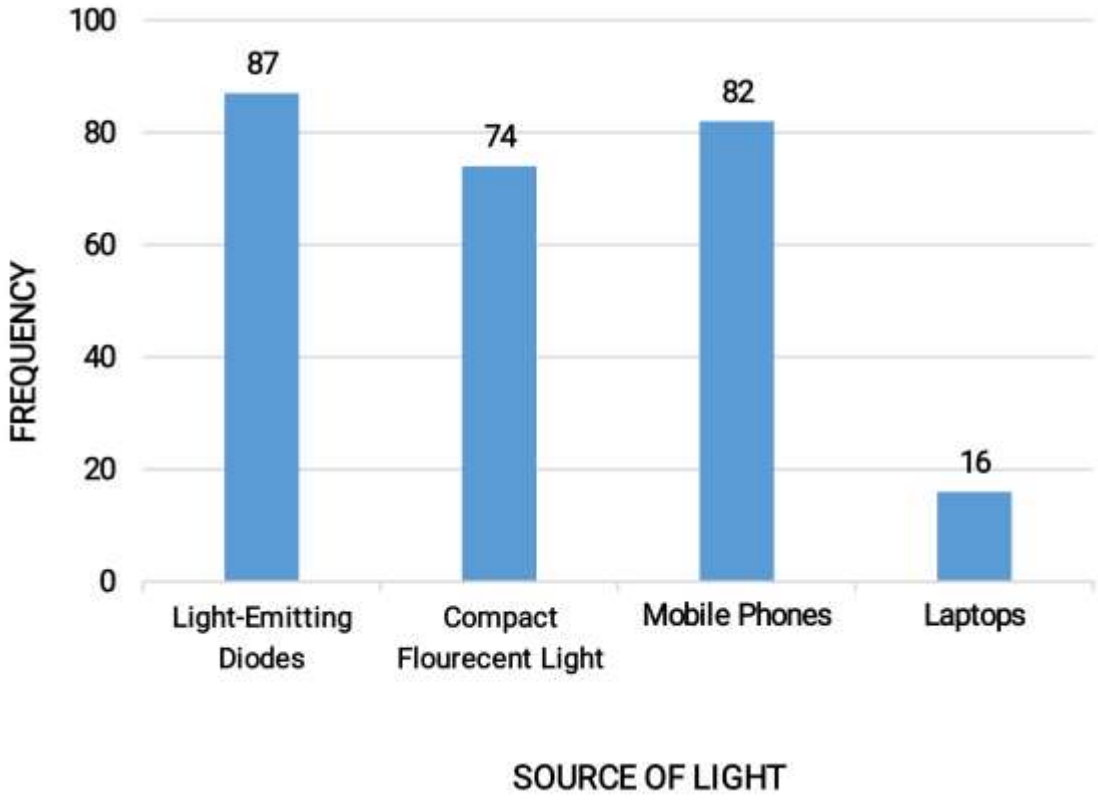

Figure 1: A Chart Showing Four Common Sources of Artificial Blue Light among College Students, and the Frequency of Their Usage by the Students

The majority of the students use a modern LED torchlight/lantern (87%) for the studies. A fewer number (72%) use the older compact fluorescent lamp. 82% is shown to use their mobile phones for their studies and other academic work, while 16% use their personal computers (laptops).

DISCUSSION

Visual problems are an important factor that can pose a serious challenge to educational activities in the school, hence good vision is required to achieve optimum results in the learning process.[14] Likewise, good vision is required to achieve optimum results in medical education.[15] Every college students in one way or the other significantly make use of a blue-light-emitting technology for their studies or other academic activities.

This study assessed the effects of blue light on visual acuity among college students. One's visual experience plays a significant role in his psychological, physical and intellectual development.[16] And according to Patil *et al*, 2013, a prolonged usage of blue-light-emitting devices is not only a stressor on the visual system but also causes musculoskeletal strain and circadian disturbances. A further study in 2018 by Zhao *et al* highlighted more that

blue light can also produce different degree of damage to corneal, crystal lens and retina, and that it is necessary to take appropriate protective measures when using blue light-related products, especially at night.

This very study has also shown that indeed blue light poses a dangerous risk to the ocular health of its users. The prevalence of visual acuity impairment after a considerably long usage of blue light was 37%. The majority of the respondents (87%) use a light-emitting diode (LED) technology torch/lantern during their night studies. 82% also uses their mobile phones for their studies and other academic works in which they have to spend many hours at once on the screen. Many others are exposed to other sources of blue light, and more even combine usage of different sources of blue light at once. The report of visual acuity status below 6/6 amongst the students was high, and this is worrisome with regards to its long term effects or cumulative effects on their vision.

A common trend among most long users of blue light devices is the Digital Eye Strain which was observed among the students following its symptoms such as headache, eye pain, heavy eyelids, redness of eyes, watery eyes, increased sensitivity to light, blurring of vision, disorder sleep cycle, amongst other eye discomforts. This calls for an urgent need for the sensitization of students and blue light users on the harmful effects of an overly steady usage of these devices. And once again, it is necessary for all to take appropriate protective measures when using any blue-light-emitting device.

CONCLUSION

Technology keeps advancing rapidly, and we have got almost no alternatives than to be part and parcel of the usage of these modern high techs. It is, however, pertinent that we are also aware of the adverse effects especially of an unchecked or uninterrupted steady use of these devices. As this study has shown, one's visual acuity becomes impaired for some moments after a prolonged exposure to blue light, accompanied also by other eye discomforts caused by digital eye strain. Very worrisome in this regard is what the long term effects of our continuous long exposure to this light could lead to, perhaps as one advance in age.

Being conscious of these harmful effects is the first step to mitigating them. Then, we must follow prescribed indications and guidelines for the safer use of these blue-light-emitting devices. In as much as these devices are great and make a whole lot of our everyday activities easier, the tech companies who produce these devices can go into more research to find how to eliminate entirely these adverse effects so that the users of these products are not harmed by the very devices which are meant to assist them. The medical world is also summoned to do more research in this regard so that as we keep advancing in technology, we may not be alongside getting ourselves blind.

RECOMMENDATIONS

Adequate sensitization on the harmful effects of long exposure to blue lights; creation of awareness for the usage of blue light filters/glasses (example: photochromic lens); taking frequent breaks from digital screens; encouraging outdoor use of blue light devices; early and proper management of impaired vision and more intake of foods that enhance eyesight are recommended. Further studies on this topic and its related topics are as well recommended.

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Conflict of Interest: None

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