Prevalence and Risk Factors of Refractive Errors among Secondary School Students in Asaba Metropolis, Delta State, Nigeria.

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ABSTRACT

Refractive error occurs when light rays are not properly focused on the retina. The purpose of the research was to evaluate eye refraction as an approach to vision improvement among Asaba metropolitan secondary school pupils, Delta state, Nigeria. A total of 259 participants who ranged in age from 10 to 17yearswere co-opted, and these were made up of 141 female and 118 male students. Distant acuity was determined using Snellen chart at 6m; Pinhole assessment was observed for uncorrected 6/12 or worse visual acuity and Subjective refraction assessment for improved visual acuity using the pinhole. Study analyzed data using Statistical Package for Social Sciences version 22.0, descriptive statistics, and Chi-square analysis at p=0.05. Refractive error was statistically prevalent in the study population at 123 (47.5%) with myopia being most prevalent at 22.78% (59). Male accounted for 47 (18.1%) with myopia accounting for 21 cases, hypermetropia was observed in 14 cases (5.4%), and astigmatism were 12 cases (4.6%). However, female accounted for 76 (29.3%) with myopia being 38 cases (14.67%), astigmatism reported as 22 cases (8.49%), and hypermetropia 16 cases (6.18%). The study observed that there is a statistically significant link between age, sex, and the distribution of refractive defect in the study population. Conclusively, the study advocates that school entrance policies in developing nations should include vision screenings and include eye examinations annually for all students as early detection and treatment of refractive errors will improve vision.

Keyword: Refractive error, Myopia, Hypermetropia, Astigmatism, Vision

Introduction

The eye responding to visible light enables humans to utilize visual information for physiological purposes including perception, regulating balance and circadian rhythm [1]. Refraction takes place at two surfaces of both the cornea and the crystalline lens: the anterior and posterior surfaces of the cornea and the crystalline lens. Each of these refractive surfaces are nearly spherical having their respective refractive optical contact. The optical system of the eye is constructed so that it creates a reduced inverted image of the visual field on the retina. The existence of four refracting surfaces increases the intricacy of refraction process. The air (an optical medium) and the cornea's anterior surface receives light beams directed toward an axis such that there are four surfaces striving to make light beams converge on each other. If the distant parallel beam of light falls on the cornea, it creates a net effect of series of refraction at these four surfaces to bring these rays to the optical system's point focus, a point that corresponds with the emmetropic eye's retina [2].

Where the refractive index difference is greatest, light undergoes the most refraction or bending, and this location corresponds with where light flows from air into the cornea. The corneal surface's refractive index, 1.3376, is comparable to the aqueous humor's refractive index – 1.336 (same for the vitreous); so, the refracting of light as the rays meet the posterior corneal surface that is concave and enters into a medium that has a somewhat lower index of refraction. Compared to the surrounding vitreous body and aqueous humor, the crystalline lens has a higher refractive index, 1.386 to 1.406, this thus makes the two media and surfaces to contribute to convergence, with the posterior surface making a larger contribution than the anterior surface due to its greater curvature and smaller radius [3]. The range of vision of the human eye can be measured from the fixation point; the direction of one's gaze. Its measurement normally varies among individuals because of variable facial architecture, but it is roughly 30° up, restricted by the brow, 45° limited by the nose, 70° inferiorly, and 100° temporally [4,3]. When both eyes are used for vision, the visual field changes to around 100° vertically and up to 190 degrees horizontally, with about 120° of that being the binocular field of view and the two uni-ocular fields being about 40° respectively. The iris and pupil may still be visible to the observer when viewed from the side at sharp angles. This suggests that at that angle, the patient might have peripheral vision [5].

The pupil can adjust the amount of light entering the eye by relaxing or contracting the dilator and sphincter muscles of the iris. This procedure regulates the pupil's size, which in turn affects how much light gets into the eye. The size difference between an adult's eyes is one to two millimeters. In humans, the sagittal section is normally 23.7 mm (0.93 in.), the transverse section is around 24.2 mm (0.95 in) horizontally, and the antero-posterior section is usually 22.0–24.8 mm (0.87–0.98 in). These measurements show no discernible variations across the sexes and age groups [6]. However, Cunningham et al. discovered a significant association (r = 0.88) between the transverse diameter and the orbital breadth [6]. The typical adult eye has a capacity of 6 cubic centimeters (0.37 cu in) and measures 24 mm (0.94 in) from anterior to posterior [6]. From a diameter of roughly 16–17 mm (0.6–0.67 in) at birth to 22–23 mm (0.89–0.91 in) by the time a child is three years old, the eyeball usually expands rapidly. The eye usually reaches its maximum size around age 12 [6].

The retina contains three different cell kinds, each of which converts light energy into the system's electrical energy, the cones that respond to intense light and enhance the perception of high resolution and chromatic vision; the rods that respond to low light intensity and contribute to the perception of poor resolution low intensity light and scotopic

vision; and, the photosensitive ganglion cells that supports modifying the amount of light that enters the retina and responds to a wide range of light intensities, so as to regulate and inhibit melatonin production and to maintain circadian rhythm or photopic vision [1]. The blind spot, an area of blindness in the eyes that is roughly 15° temporal and 1.5° below the horizontal, is coursed nasally by the optic nerve. It is roughly 7.5° high by 5.5° broad [7].

Outdoor activities have been identified as a contributing element to the frequency of refractive errors [8]. Myopia incidence rate was found to be 10% lower in children who participated in various outdoor activities and this notion supports bright light having preventative effect on the development of myopia. According to their proposed mechanism, light increases the retina's production of dopamine, which in turn stops myopia from developing by preventing ocular elongation throughout the process of eye development [9–11].

In today’s world, students are seen increasingly wearing prescribed glasses to treat various sorts of refractive problems at school. Following the Covid-19 shutdown as students were confined to their homes, this challenge appeared to have doubled and the increasing rate of screen time from phones and television sets. The current study, in the post-Covid-19 shutdown era, aimed at identifying the prevalence and risk factors for refractive errors among secondary school children in the Asaba metropolitan area.

Material and Methods

Study was a cross-sectional in nature and was carried out at three secondary educational institutions: West-End Mixed Secondary School, Asaba; St. Patrick's College, Asaba (an all-boys school); and Anglican Girls' Grammar School, Asaba, Nigeria. However, using **[13]** method in determination of the fraction of the target population that has refractive errors, current study adopted 259 as sample size. The study population consists of all school children who underwent screening at their schools and fell within the age bracket (10–17 years). During the vision screening exercise, 513 individuals in total were screened; 259 of these patients that satisfied the inclusion criteria were recruited for the study. One hundred and eighteen males and one hundred and forty-one females comprised the population under investigation.

Research material include questionnaires used to gather socio-demographic data from subjects and parents, examination sheets, occluder, Snellen distant and near acuity charts, Heine Beta200 retinoscope, auto-refractometer, Keeler monocular direct ophthalmoscope, trial lens set and frame, slit lamp biomicroscope.

Data Collection

Snellen's visual acuity chart at 6 meters was used to determine subjects’ acuity. Pinhole was further utilized for evaluating acuity of children with subnormal vision of 6/12 or worse. Children who improved on the pinhole visual acuity exam had their eyes subjectively refracted using a conventional refraction trial set. Further testing was done for children who had subnormal vision (6/12 or worse) when they first arrived and could not improve their vision with pinhole testing. The examinations include ocular alignment at 0.5 and 4 meters to check for obvious or latent deviation; ocular motility; external inspection using a pen torch; posterior segment examination using an ophthalmoscope and/or slit lamp biomicroscope if necessary.

The frequency of refractive errors was evaluated with non-cycloplegic refraction and was defined as follows: one or both eyes must have myopia of less than 0.5 D, hypermetropia of more than 0.5 D, and astigmatism of less than 0.50 D cylindrical refraction **[12].** Refractive errors were assessed using either the Heine Beta200 retinoscope or an

auto-refractometer. Visual acuity of 6/9 or below in the better eye was considered subnormal vision, while vision worse than 6/18 in the better eye was considered visual impairment. After each eye examination, the main reason for subnormal vision of 6/12 or worse was noted. The detected causes were subsequently divided into amblyopia, cataract, retinal diseases, corneal opacity from any cause, refractive error, and other factors.

Inclusion criteria include the age bracket of between 10 and 17 years with healthy eyes and residence in Asaba metropolis. Subjects with obvious ocular defects and those within that age range but who are not students at the selected schools were excluded. The Ministry of Education for Delta State granted ethical approval and the Helsinki Declaration of the World Medical Association (1968), as revised in 2013, served as the guide for conducting the study **[14]**. The subjects' parents or guardians gave their informed consent after ascertaining their children's desire to take part, and records were de-identified as anonymous in compliance with best standard practices.

Data Analysis

Descriptive statistics (tables, bar charts, and pie charts), Chi-square analysis, and the study data were examined using the Statistical Package for Social Sciences (SPSS) version 22.0. Because of this, the researcher was able to determine the statistical relevance of the relationship between the research population's age, gender, and refractive error distribution.

Results.

Table 1: Frequency distribution of socio-demographic variables in the population under study.

AGE RANGE	GENDER		
(YRS)	MALE%	FEMALE%	TOTAL
10 – 11	17 (6.56%)	21(8.11%)	38(14.67%)
12 – 13	29 (11.2%)	32(12.36%)	61(23.55%)
14 – 15	41(15.83%)	49(18.9%)	90(34.75%)
16 – 17	31(11.97%)	39(15.06%)	70(27.03%)
TOTAL	118(45.56%)	141(54.44%)	259(100%)

Table 2: Age distribution of male students with Refractive errors

Age Range	Normal Visual	Types of errors of refraction			
(Years)	Acuity (Males)	Myopia	Hypermetropia	Astigmatism	Total RE(%)
10 – 11	10(3.86%)	2(0.77%)	1(0.39%)	3(1.16%)	16(6.18%)
12 – 13	17(6.56%)	5(1.93%)	3(1.16%)	2(0.77%)	27(10.42%)
14 – 15	25(9.65%)	8(3.09%)	5(1.93%)	2(0.77%)	40(15.4%)
16 – 17	19(7.34%)	6(2.32%)	5(1.93%)	5(1.93%)	35(13.5%)
Total	71(27.4%)	21(8.1%)	14(5.4%)	12(4.6%)	118(45.46%)

Table 3: Age distribution of female students with refractive errors.

Age Range	Normal Visual	Refractive errors			
(Years)	Acuity	Myopia	Hypermetropia	Astigmatism	Total RE(%)
10 – 11	12(4.63%)	9(3.47%)	5(1.93%)	3(1.16%)	29(11.2%)
12 – 13	16(6.18%)	12(4.63%)	3(1.16%)	5(1.93%)	36(13.9%)
14 – 15	25(9.65%)	15(5.79%)	5(1.93%)	8(3.09%)	53(20.46%)
16 – 17	12(4.63%)	2(0.77%)	3(1.16%)	6(2.32%)	23(8.88%)
Total	65(25.1%)	38(14.67%)	16(6.18%)	22(8.49%)	141(54.44%)

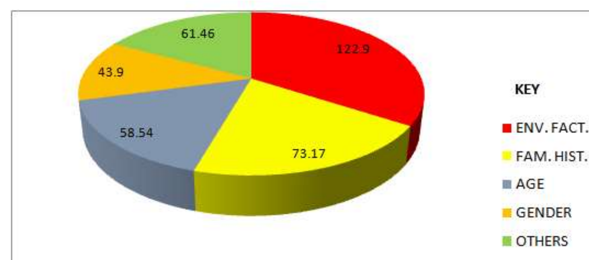

Figure 1: Distribution of the risk factors for refractive errors.

Study revealed Age, Gender, Environmental factors and Positive family history as risk factors.

Table 4: Frequency of errors in refraction in the study population.

Age (Years)	Ref. Error	Normal	Total
10 – 11	23	22	45
12 – 13	30	33	63
14 – 15	43	50	93
16 - 17	27	31	58
Total	**123**	**136**	**259**

Table 4 above indicates the frequency of errors of refraction in the study population.

1. **HO:** There is no significant relationship between the prevalence of refractive error and age of onset in secondary school students aged 10 – 17yrs in Asaba metropolis.

X^2 α = 0.05(5%)

Chi Square (x^2) cal = 588.01 > (x^2) crit = 3.84, which is statistically significant.

Thus, the null hypothesis—which claimed that there was no meaningful correlation between age and refractive error—was rejected for study population.

2. **HO:** There is no significant difference in gender distribution of errors of refraction in students aged 10 – 17yrs in Asaba metropolis..

X^2 α = 0.05(5%)
Chi Square (x^2) cal = 104.41

Thus, the null hypothesis that there was no discernible change was disproved for study population.

3. **HO:** There is no significant difference between gender and refractive error dominance in secondary school students aged 10 – 17yrs in Asaba metropolis.

X^2 α = 0.05(5%)
Chi Square (x^2) cal =168.02.

Thus, the null hypothesis that there was no substantial difference was disproved because there were 76(29.3%) number of refractive error cases for females with myopia presenting 38(14.76%) cases, hyperopia 16(6.18%) and astigmatism 22(8.49%). Males recorded 47(18%) refractive error cases with myopia 21(8.1%), hyperopia 14 (5.4%) and astigmatism 12(4.6%). This makes Myopia the most dominant form of refractive error and most common with the female gender. The greatest number of participants in the study, 160 (61.78%), were from the last two age groups (14–15 years old and 16–17 years old).

Discussion

This study found that 47.55% of participants had refractive error similar to previous report by **[15].** Myopia was the most common condition among them, occurring in 38 (14.67%) kids, followed by astigmatism (22.8%) and hypermetropia (16.18%). Similar to this study conducted in Nigeria **[16]** and also that reported by **[17]** revealed that women are more likely than men to be myopic.

The two primary risk variables in this study for refractive errors are environmental factors and a favorable family history. Among the 123 reported instances of refractive error, 42 (34.15%) cases were caused by environmental factors, and 25 (20.33%) cases had a favorable family history (genetics). A combination of environmental and genetic factors is thought to be the cause of myopia **[10].** The risk factors include working close or doing work that requires close focus, staying indoors more often than outside, urbanization, and a favorable family history of the defect in refraction. Also linked to greater socioeconomic and educational status are refractive errors **[18].** People who are literate spend more time reading and/or using technology indoors. Myopia can be avoided by engaging in more outdoor activities, and there may be a dose-response relationship between the time spent outdoors and the chance of developing myopia **[11].** It is significant to remember that myopia prevalence has been demonstrated to decrease merely by being outside without participating in a sport or activity **[9].** This concept, which has been investigated in numerous research, contends that exposure to light has a substantial effect on the prevention of myopia. In current clinical research, it was discovered that children who engaged in outdoor activities had a myopia reduction of about 10%. Several investigations have likewise supported this phenomenon. This theory believes that myopia during outdoor activities is prevented by the light exposure of the surroundings. Studies have also demonstrated the prevention of myopia production by bright light. The mechanism supporting this theory is the fact that light promotes the retina's production of dopamine, and that dopamine's subsequent inhibition of the eyeball's lengthening throughout the process of eye development prevents myopia **[8].** This study's high frequency of myopia (47.55%) supports these

conclusions given that students were confined to their homes and electronic devices during the lockdown brought on by the COVID-19 pandemic.

For this investigation, gender and age were also mentioned as risk variables for refractive defects. They contributed correspondingly (16.3%) and (12.2%). The most prevalent cause of vision impairment in the world is refractive defects in distance vision that have not yet been corrected, primarily myopia, and a drop in this trend is not anticipated any time soon. Several investigations have documented the most prevalent type of refractive error in Africa. While some research revealed the most prevalent distance refractive defect was myopia, with a prevalence incidence of 52.4%; astigmatism and hyperopia were also noted in other investigations **[19]**. In similar hospital-based investigations, these findings concur with those of **[20]** in Ile-Ife with an incident rate of 22.7%, those of **[21]** in Owerri with an occurrence of 23.4%, and those of population-based study in Southern India, where the prevalence was 26.99%. Adeoti and Egbewale's investigation in Osobgo revealed a lower rate of occurrence 39.2% **[21].** When compared to men, more women developed myopia, in varied degrees **[22].** According to an epidemiological analysis of the condition, women were more likely than men to have myopia. Myopia prevalence peaked between the ages of 10 and 30 years, however it was discovered that the degree of myopia varied with age. The majority of myopia instances have been seen arise between the ages of 1 and 10 years; nevertheless, there is a period of relative stability between the ages of 12 and 50 years. When **[15]** examined how frequently students were found to have refractive problems, they discovered that children's refractive defects varied statistically significantly according to their age, gender, and ethnicity. They specifically reported that the prevalence and severity of myopia were higher in older students than in younger ones. Also, they found significant variations in myopia prevalence and severity among students of different ages and genders, but not between ethnic groups.

The study also identified additional diseases that increase likelihood of having subnormal visual acuity (refractive errors). 21 (17.1%) of the total refractive error cases in this investigated population were attributable to a few of these conditions. Nine (7.32%) of the individuals had corneal scars, five (4.07%) had a history of birth preterm, six (4.88%) had lens disorders, and one (0.81%) had congenital ptosis. **[15]** stated that kids who have poor visual acuity due to different ocular pathological conditions, premature newborns, or a history of oxygen consumption in the neonatal period appear to present with visual impairment. **[38]** also noted that amblyopia, which is typically linked to high levels of poverty and illiteracy in Somaliland with regard to the subpar health system in Somalia, is the second most frequent reason for vision impairment in youngsters. According to **[36]** and **[37],** inherited factors, dietary habits, and lifestyle choices may all contribute to the increased occurrence of refractive errors. Only 16 (13%) of the 123 (47.5%) youngsters who had refractive problems in this investigation were already known to wear glasses; the other patients were unaware they had the condition. This negative reaction to wearing glasses could result from the parents' and the child's lack of knowledge about the condition, the general misconception that wearing glasses is uncool, the price of getting a pair, one's appearance, peer pressure, and the false belief that glasses may worsen or cause vision problems.

According to the study, there was no statistically significant correlation between the frequency of refractive error and age in the study population. The relationship was statistically significant at confidence intervals of $x^2 = 0.05$ (5%), χ^2 cal = 588.01, and χ^2 critical = 3.84. Consequently, there was a strong correlation between the age of the research sample and the occurrence of refractive errors. Myopia was reported to have the greatest

prevalence rate at 110 (9.1%) in **[33]** study, which included 189 (15.7%) children with refractive defects with a 95% confidence interval of 13.7–17.8% and 1015 (84.3%) who were emmetropic. With a prevalence incidence of 47 (3.9%), astigmatism came second, followed by hypermetropia with a 32 (2.7%) prevalent incidence. Refractive error prevalence was revealed to be strongly correlated with children's ages (P = 0.011). However, it was correlated with gender (P = 0.073), class, or academic standing (P = 0.168). **[34]** explained the rise in myopia prevalence with age by noting how little time many youngsters spend engaging in outside activities. This is associated with an important cause of myopia rise in numerous studies **[35].** In a research study published in 2020, **[15]** also noted that an increased incidence of myopia was seen in students between the ages of 7 and 11 years. They also highlighted the effects of age and gender on the prevalence of myopia, but not ethnic group. These results concur with the current investigation.

A statistically significant gender bias was found in this study when the relationship between gender and refractive error was examined using chi-square analysis, at $x^2 = 0.05$ (5%) and χ^2 cal = 104.41. This led to the rejection of the null hypothesis that there was no significance. Put differently, the research sample's distribution of errors of refraction was skewed toward women. **[16]**discovered that female children were nearly four times as likely to have myopia as male children across all of the different age groups in their research. Also, compared to their male counterparts, more women experienced myopia of varied degrees. In a 2006 epidemiological assessment of myopia, **[22]** found that the frequency of myopia was higher in women than in men, while **[40]** in Iran also reported no correlation. **[39]**, who analyzed the pattern and degree of astigmatism, did also not find any statistically significant link between gender and magnitude of astigmatism.

At a Chi-square (χ^2) cal = 168.02, the correlation between gender and the dominance of refractive defects likewise revealed a statistically significant skew in favor of women. It was discovered that females were more likely to have refractive defects 76 (61.8%) compared to males, who had 47 (38.2%). The most common kind of refractive anomaly, myopia, in the study population, was more occurrent amongst females, where it affected 38 (30.9%) as opposed to 21 (17.1%) of the male population. This contradicted the null hypothesis that there was no significant change. That is, in the sample population, there was a substantial relationship between gender and the preponderance errors in refraction. In line with this investigation, **[32]** and **[17]**reported that myopia was significantly more common in females than in males. In particular, this study's use of logistics regression analysis identified gender as one myopia risk factors. This can be explained by the fact that female students are less talkative and reserved than male students, and they participate in far fewer outdoor activities. Moreover, women reach adulthood earlier than their male counterparts.

Conclusion

The most common refractive error was myopia (59, 22.8% of the population),astigmatism (34, 13.1%) and hyperopia (11, 9%) followed respectively. Environmental and positive family history were reported as major predisposing factors.

Recommendations

School authorities should adopt eye examination as entry requirement and as well adopt yearly vision screening for prompt intervention.

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