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The Prevalence Of Refractive Errors In Abia State And Factors Affecting Myopia And Hyperopia Across The Three Geographical Zones In Abia State, Nigeria

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Abstract

Uncorrected refractive error is a cause of visual impairment and poor performance among students. This cross-sectional study's objective aimed to determine the prevalence and factors affecting refractive errors in Abia State. A school screening was done across all the 3 geographical zones making up the state. 5217 participants took part in the study.

The results showed there was a statistically significant effect of gender and age groups on refractive error $p=1.52 \times 10^{-75}$ across the state though this effect varied across the different sub-groups Cramers effect on size showed it was a medium effect. There was significant effect of refractive error based on the level of education $p= 1.71 \times 10^{-99}$ with small Cramers effect. For those in the primary schools, hyperopia was more prevalent followed closely by myopia. Those in secondary school were slighly more myopic and that was the same trend for those in tertiary education. This result was the same across all the 3 geographical zones of the state with p=0.00

Analyis done by whether it was a public or private school, showed a significant relationship between school type and refractive error, $p= 8.72 \times 10^{-13}$ but Cramers effect V=0.112 showed a weak relationship. Both Myopia and hyperopia was more common in public schools in Abia State compared to private schools. In Abia central zone, there was no statistical relationship p=0.262 between type of school and refractive errors, but hyperopia was higher compared to myopia in both public and private schools. With respect to myopia though, it was found to be higher in public schools. But in Abia South p= 0.021 and Abia South p= 0.000, there was a statistically significant relationship. In Abia South and north, myopia was more common across both school types, though higher in public schools.

The location of the schools whether rural, semi-rural or urban areas affected the distribution of refractive error. Statewide, there was a statistical significance between the location of school and refractive errors $p= 4.97 \times 10^{-39}$. This effect thought weak using Cramers method v= 0.14 was still present with myopia and hyperopia being almost the same. In different zones, in Abia Central, p=0.106 there was no statistical effect of location on refractive error. Hyperopia compared to myopia was more common across all the locations in Abia Central, Abia South p=0.001 showed there was a significant effect in refractive error which was more myopic across all the locations. Abia North p=0.000, had a similar result with Abia South with myopia being more prevalent across all schools locations

The time spent on studying affected refractive error $p=1.17 \times 10^{-8}$ with negligible Cramers effect v= 0.09. In Abia Central, majority had responded to yes to long study times, being the same with both those who were myopes and hyperopes, while those who responded no to the question, were more hyperopes. Myopes spent longer hours studying 5-12 hours, whereas hyperopes less hours, less than 5 hours studying. In Abia South p=0.271 showed no significant relationship between study time and refractive errors. In Abia North P=0.757 had a similar response to Abia South with myopes having more study time. The time spent on homework was similar to school study time in Abia State $p= 2.782 \times 10^{-51}$. Cramers effect v= 0.16 was weak. More myopes spent longer studying time compared to hyperopes. In Abia central p=0.524, not statistically significant while Abia South and Abia North p= 0.00, which was statistically significant.

The analysis on the time spent outside by the students showed a relationship between time spent outside and refractive errors $P= 1.91 \times 10^{-11}$ in Abia State, with cramers effect v= 0.11. There was no statistically significant effect across all the 3 zones with Abia Central p= 0.571, Abia South p=0.108 , Abia North p= 0.304 respectively. The type of lighting available for study such as desklamp, room light, natural light and candle light statistically affected refractive errors $P= 1.396 \times 10^{-18}$ with cramers effect = 0.37. In Abia Central p= 0.515 and Abia North 0.131 respectively, there was no statistical effect shown between the type of lighting available for study and refractive error. But Abia South p= 0.000 showed a statistical effect between lighting

and refractive error. All the different types of lighting available was used equally across all the different refractive error groups except in Abia South where more myopes used more desk and room lights.
There was a significantly significant relationship between time spent on screen and refractive errors p= 1.289 x $10^{-87,}$ and cramers effect v=0.15. In Abia Central, yes and no response p= 0.514 length of time p= 0.470 showed no signifcant relationship between screen time and refractive error, hyperopes were more. In Abia South, p= 0.000 both to yes and length of study time showed there was a significant relationship between time and refractive errors, with myopes spending more time on screen >1 hour, compared to hyperope. The response and p value was similar for Abia North and South with more myopes spending more screen time. We tested for effect of parents occupation to refractiver error distribution and there was a statistical effect p=1.51 x 10^{-5} which was weak with cramers method v= 0.08. This effect was lost in sub groups, With Abia Central p= 0.742, Abia North p= 0.859 and only seen in Abia South p = 0.03 where majority was mostly myopic compared to their other counterparts in other zones. Most of the participants, their parents had blue collar jobs, which involved being self employed, menial jobs etc in order to keep a home, and the refractive errors were spread out equally. Hence the results showed the importance of proper education and advice to both parents and the students on correction of refractive errors.

Keywords: *Myopia, prevalence, Abia State, young, school.*

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I. Introduction

The discussion on myopia has been a hot topic for the past 15 years with new exciting advances on myopia control (Kaiti *et al*., 2022; *Liu et al*., 2024; Lawrenson *et al*., 2023). Brian Holden Institute did an extensive research on the growing pandemic of myopia and its future implications (Holden *et al.,* 2015). Lawrenson *et al.*, (2023) did an extensive review on all the different options available ranging from drops to optical management (Lawrenson *et al.*, 2023).

Myopia is caused by excessive refractive power of the cornea or lens or a longer than normal axial length, with the latter accounting for over 95 per cent of human myopia(Cho & Tan, 2019). Different definitions abound on the different degrees of myopia. Onu *et al.,* (2020) reported that the pupil sizes of young adults varied with the degrees of myopia as found amongy university students. Some have defined high myopia as a refractive error of at least -5.00DS, -6.00DS or -8.00DS (Hayashi *et al*., 2010; Xu *et al*., 2010; Holden *et al*., 2017; Kinoshita *et al*., 2018).

Many prevalence studies which are mainly found in other continents but not in Africa show that there is a large burden of myopia especially among the Asian children and community, which are affected by a lot of factors (Wong and Saw, 2016; Xian & Zou, 2020; Rudnica *et al.,* 2016; Onu *et al.,* 2014; *Onu et al.,* 2020; Ahuama & Atowa, 2019). Therefore this study looked at a large population of students across different educational levels in a state across the 3 geographical levels to determine the prevalence of refractive errors especially myopia and the associated factors.

II. Methodology

The study is an prospective study design. This is a prospective study as a survey was carried out on the selected population. It is a research design in which a group a group of people were studied by screening and eye examination of only a few people considered to be eligible.

Sample size
The sample calculation was done using acceptable standards as described by Althubaiti (2022).

It was a cross-sectional study done in both public and private schools. A multi stage random sampling technique was used in selecting the participants.

The Cochrane formula for calculation of sample size as used by the WHO in tuberculosis surveys was used for this work.

$$n = \frac{t^2 \times p(1-p)}{m^2}$$

Where n= required sample size
t= confidence level at 95% which is 1.96
p= estimated prevalence of myopia in the project area, approximately 10%
m= relative precision was about 5%, although absolute precision was used in the calculation.

p, which is the estimated prevalence of myopia in the project area was estimated to be about 10%.

n= 1.96 X 1.96 X 0.1 X 0.9 = 138.2976
0.05 X 0.05

Applying cluster correction 0f 2.33, we have a total of 322.23

Applying variables to the sample size, we use a multiplication factor of 17 to account for the variables to be analysed in regression analysis.

322.23 X 17 = 5477.967936.

Therefore the total estimated population size for the state was 5478 study participants across all the schools in the state. These were primary, secondary and tertiary institutions but in 5217 participants.

The study was done across the 3 senatorial/geographical zone of the state (Fig 1 and 2)

- Abia South Senatorial Zone with 1725 participants
- Abia North Senatorial Zone with 1525 participants
- Abia Central Senatorial Zone with 1967 participants

Fig 1: Map of Abia State showing the 17 local governments across the 3 senatorial zones

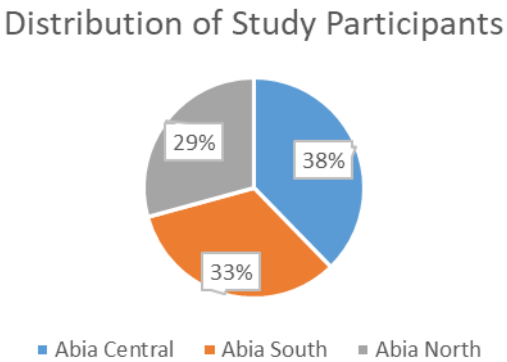


Fig 2: Distribution of study participants in Abia State.

10 schools was selected in each zone. The screening involved the setting of an eye camp and screening using snellen charts, pen torches, ophthalmoscope, retinoscope, trial frames and lenses for refraction and this was done by a team of final year students from the department of Optometry, Abia State University Uturu, Nigeria.

Ethical Considerations

The study was considered by the departmental board of optometry and the directorate of research and publications of Abia State University Uturu, before approval was given. An ethical clearance was given for the work. Also approval from the various Boards of Authority in charge of Primary,Secondary and Tertiary Institutions, Abia State Universal Basic Education Board (ASUBEB) and Secondary Education Management Board (SEMB) was obtained.

The subjects were informed about the research and an informed consent form was duly obtained from the schools, parents and gaurdians in the cases where it applied before the commencement of the research.

Statistics

A questionnaire was created to collect life style questions. This was populated into Microsoft excel sofware and was analysed using SPSS software. The analysis was done using a Chi-square test and pearson spearman correlation testing, to tests the hypothesis.

III. Results

Demographics

The study population was 5217 participants in total, which were spread out among the different geographical zones of the state. Abia Central had 1967 (37.73%) participants which was the highest, closely followed by Abia South 1725 (33.06%) and finally Abia North 1525 (29.23%) Fig 3.

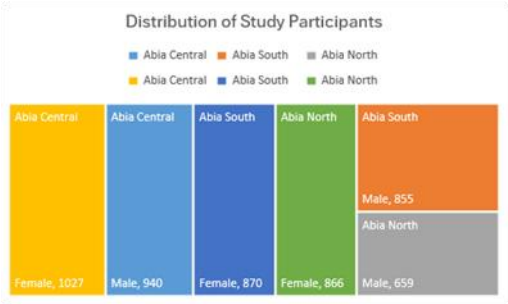


Fig 3: Study participants by gender

More females 2763 (52.96%) took part in the study compared to males 2454 (47.04%). The distribution based on gender was fairly similar, especially with Abia south 855 (49.56%) males to 870 (50.43%) females; though slightly more females participated in Central 1027 (52.21%) and North 866 (56.78%) geographical zones compared to males 940 (47.78%) and 659 (43.21%) respectively Fig 3.

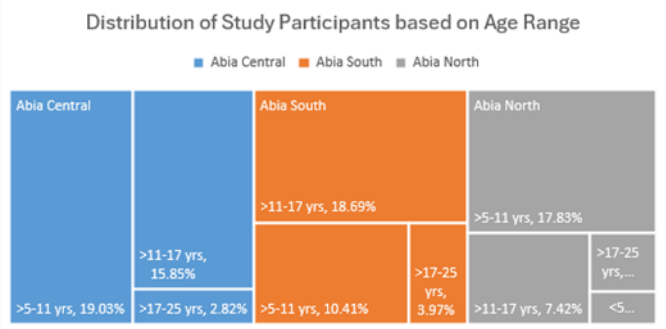


Fig 4: Distribution of participants by age range

The study participants ages ranged from below 5 years to 25 years. The majority of study participants were found in the ages of >5-11 and >11-17 years respectively across all 3 geo-political zones. These accounted for a collective 89.23% (Fig 4).

Table 1: Distribution based on educational level.

	Nursery	Primary	Secondary	Tertiary	Total
Abia Central	-	993 (50.5%)	836 (42.5%)	138 (7.0%)	1967
Abia South	-	527 (30.6%)	992 (57.5%)	206 (11.9%	1725
Abia North	372 (24.4%)	629 (41.2%)	422 (27.7%)	102 (2.7%)	1525
	372 (7.13%)	2149 (41.19%)	2250 (43.13%)	446 (8.55%)	5217

The study participants educational levels varied from nursery to tertiary education levels. The majority of study participants were found in the primary and secondary school levels respectively across all 3 geo-political zones. These accounted for a collective 84.32% (Table 1).

Table 2 : Distribution based on school types

	Private	Public	Total
Abia Central	805 (40.9%)	1162 (59.1%)	1967
Abia South	377 (21.9%)	1348 (78.1%)	1725
Abia North	1234 (80.9%)	291 (19.1%)	1525
	2416 (46.31%)	2801 (53.69%)	5217

The study participants were in either a private or public school education. The majority of study participants were found in the public schools respectively in Abia Central 1162 (59.1%) and North 1348 (78.1%) geo-political zones, while Abia North had more private school participants, 1234 (80.9%). But in all across the 3 geo-political zones, the public schools had more participants 2801 (53.69%) compared to private school 2416 (46.31%) (Table 2).

Table 3 : Distribution by study location

	Rural	Semi-urban	Urban	Total
Abia Central	464 (23.6%)	628 (31.9%)	875 (44.5%)	1967
Abia South	906 (52.5%)	490 (28.4%)	329 (19.1%)	1725
Abia North	1221 (80.1%)	304 (19.9%)	0	1525
	2591 (49.66%)	1422 (27.26%)	1204 (23.08%)	5217

The study participants were in either a rural, semi-urban or urban location. The majority of study participants were found in the rural schools especially in Abia South 906 (52.5%) and North 1221 (80.1%) geo-political zones, while Abia central study participants were in the semi-urban 628 (31.9%) and urban areas (44.5%) respectively. But in all, across the 3 geo-political zones, those living in the rural areas had more participants 2591 (49.66%) while the urban 1204 (23.08%) and semi-urban areas 1422 (27.66%) were pretty similar to each other respectively (Table 3).

Table 4: Number of hours spent studying privately

	No	Yes	Total
Abia Central	943 (47.9%)	1024 (52.1%)	1967
Abia South	263 (15.2%)	1462 (84.8%)	1725
Abia North	800 (52.5%)	725 (47.5%)	1525
	2006 (38.45%)	3211 (61.55%)	5217

Many of the students were asked if they spent time studying privately. Majority responded yes to the question 3/5 (61.55%). Most respondents were from both the central and southern regions whereas those from Abia North was fairly split equally between both responses (Table 4).

Table 5: The length of time spent studying

	<1 hour	1-5 hours	>5-12 hours	>12 hours	Total
Abia Central	641 (32.6%)	696 (35.4%)	580 (2.5%)	50 (2.5%)	1967
Abia South	342 (19.8%)	1383 (80.2%)	-	-	1725
Abia North	625 (41.0 %)	897 (58.8%)	3 (0.20%)	-	1525
	1608 (30.82%)	2976 (57.04%)	583 (11.18%)	50 (0.96%)	5217

The length of time spent studying by the participants varied. 1608 (30.82%) spent less than an hour on study time, whereas the majority 2976 (57.04%) spent at least within 1-5 hours. The number of hours spent was >5 hours. Among the geographical zones, Abia central had the highest number of participants who studied over 5 hours as compared to all the others, though it was a fairly equal spread among all the hours in this central area. In Abia South, on the other hand, majority spent time 1-5 hours study time, while in the North, it was almost the same, though slightly higher on the 1-5 hours range (Table 5).

Table 6: Hours spent studying at school.

	<1 hour	1-5 hours	>5-12 hours	>12 hours	Total
Abia Central	1781 (90.5%)	186 (9.5%)	-	-	1967
Abia South	342 (19.8%)	1383 (80.2%)	-	-	1725
Abia North	642 (41.0%)	879 (58.8%)	-	4 (0.20%)	1525
	2765 (53%)	2448 (46.92%)	-	4(0.08%)	5217

Majority said they spent either <1hour or between 1-5 hours studying at school. The response was fairly similar across all the 3 geographical zones. This was almost similar to the amount of time reported as private studying time (Table 6).

Table 7: Lighting conditions for study

	Candle	Ceiling/Room light	Desk Lamp	Lantern	Natural Light	Sky Light	Total
Abia Central	60 (3.1%)	386 (19.6%)	272 (13.8%)	144 (7.3%)	993 (50.5%)	112 (5.7%)	1967
Abia North	-	663 (43.5%)	635 (41.6%)	38 (2.5%)	178 (11.7%)	11 (0.7%)	1525
Abia South	6 (0.3%)	628 (36.4%)	1036 (60.1%)	30 (1.7%)	13 (0.8%)	12 (0.7%)	1725
	66 (1.27%)	1677 (32.14%)	1943 (37.24%)	212 (4.06%)	1184 (22.70%)	135 (2.59%)	5217

The ligthing conditions which the participants studied in varied. Majority used desk lamp 1943 (37.24%) which was the same in Abia Noth 635 (41.6%) and Abia south 1036 (60.1%) geographical zones. This was closely followed by Ceiling or room light 1677 (32.14%), in the geographical zones, was high in Abia North 663 (43.5%) and south 628 (36.4%) too. Natural light was the 3rd highest 1184 (22.70%) with the Abia central geographical zone being highest in it. Other forms of lighting like use of sky light, lantern and candle were low and sparsely distributed across all the geographical zones (Table 7).

Table 8: Length of breaks

	0-10 mins	>10-20 mins	>20-30 mins	>30-40 mins	>40-50 mins	>50-60 mins	>60 mins	Total
Abia Central	442 (22.5%)	523 (26.6%)	599 (30.5%)	183 (9.3%)	104 (5.3%)	76 (3.9%)	40 (2.0%)	1967
Abia South	420 (24.3%)	558 (32.3%)	6 (0.3%)	207 (12.00 %)	518 (30.0%)	16 (0.9%)	-	1725
Abia North	768 (50.4%)	438 (28.7%)	126 (8.3%)	185 (12.1%)	8 (0.5%)	-	-	1525
	1630 (31.24%)	1519 (29.11%)	731 (14.01%)	575 (11.02%)	630 (12.08%)	92 (1.8%)	40 (0.77%)	5217

The majority of study participants said yes to taking breaks from study. The length of breaks varied across, with majority taking shorter breaks of about 0-20 mins across all geographical zones. 1630 (31.24%) 0-10 mins while 1519 (29.11%) >10-20mins. Others similarly had slightly longer breaks between >20 mins -50 mins. 731 (14.01%) had >20-30 mins break which was slighly more in Abia central geopolitical zone, 575 (11.02%) had >30-40 mins which was fairly spread out across all the 3 geopolitical zones while 630 (12.08%) had >40-50 mins break which was highest in Abia South geographical zone. A very few participants took longer break of >50 mins , 92 (1.8%) ->1hour, 40 (0.77%) (Table 8).

Table 9: Response to Headaches, No Headaches or did not notice

	Headaches	No Headaches	Did Not notice	Total
Abia Central	329 (16.7%)	1609 (81.8%)	29 (1.5%)	1967
Abia South	120 (7.0%)	1504 (87.2%)	101 (5.9%)	1725
Abia North	45 (3.0%)	1480 (97.0%)	-	1525
	494 (9.47%)	4593 (88.04%)	130 (2.49%)	5217

Responses to whether they had Headaches, no headaches with study varied, as some also did not notice. Majority did not have any headache 4593 (88.04%), and this was the same across all the 3 geographical zones with Central 1609 (81.8%), South 1504 (87.2%) and North 1480 (97.0%) respectively. A few though did report headaches 494 (9.47%), with Abia Central having the highest 329 (16.7%), closely followed by South 120 (7.0%) and North 45 (3.0%). Similarly, some did not notice any form of headache 130 (2.49%) with Abia South respondents being highest 101 (5.9%), Central 29 (1.5%) and none from Abia North (Table 9).

Those who had headaches had different frequencies to it with majority reporting 1-4x while a few just >5x. This was pretty similar across all zones. The time the headaches were experienced varied, across different times of the day like morning, afternoon, evening/night, and none specific times. It was evenly spread across all the different times of the day, also across all the geographical zones.

Table 10 : Time spent outdoors

	Yes	No	Total
Abia Central	1596 (81.1%)	371 (18.9%)	1967
Abia South	1367 (79.2%)	358 (20.8%)	1725
Abia North	1482 (97.2%)	43 (2.8%)	1525

	4445 (85.20%)	772 (14.80%)	5217

Participants were asked if they spent time outdoors. Majority responded yes to the question 4445 (85.20%) which was fairly spread out across the 3 zones with central 1596 (81.1%), South 1367 (79.2%) and North 1482 (97.2%) while a few 772 (14.80%) responded no, with central 371 (18.9%) and South 358 (20.8%) having more respondents (Table 10).

Table 11: Time spent outside based on hours

	<1 hour	>1-3 hours	>3-6 hours	>6-9 hours	Cannot quantify	Total
Abia Central	230 (11.7%)	481 (24.5%)	1148 (58.4%)	99 (5.0%)	9 (0.5%)	1967
Abia South	358 (20.8%)	1112 (64.5%)	254 (14.7%)	1 (0.1%)	-	1725
Abia North	-	103 (6.8%)	613 (40.2%)	809 (53.0%)	-	1525
	588 (11.27%)	1696 (32.51%)	2015 (38.62%)	909 (17.42%)	9 (0.17%)	5217

The time spent outside by the participants varied. Majority, 2015 (38.62%) spent >3-6 hours with Abia central 1148 (58.4%) being the majority. This was closely followed by 1696 (32.51%) who spent >1-3 hours; with them being mainly from Abia South zone 1112 (64.5%). A good number or respondents spent >6-9 hours outdoors, 909 (17.42%) with Abia North zone accounting for the most 809 (53.0%). But there were some who spent less time outdoors 588 (11.27%), found in Central 230 (11.7%) and South 358 (20.8%), with none from the North (Table 11).

Table 12: Access to phone

	Always	Never	Occasionally	Did not specify	Total
Abia Central	395 (20.1%)	1390 (70.7%)	162 (8.2%)	20 (1.0%)	1967
Abia South	429 (24.9%)	242 (14.03%)	1054 (61.1%)	-	1725
Abia North	1040 (68.2%)	6 (0.4%)	479 (31.4%)	-	1525
	1864 (35.72%)	1638 (31.40%)	1695 (32.49%)	20 (0.38%)	5217

Access to screen time varied across the respondents with majority responding yes. Some always had access, others never had access, some had occasional access, and there was no response from others.

Response specifically to access to screentime: phone, was varied. 1864 (35.72%) responded always having access to phone which was highest in Abia North zone 1040 (68.2%). 1695 (32.49%) had occasional access which was highest in the Abia South Zone 1054 (61.1%). 1638 (31.40%) responded never having access to phone which was highest in the Abia Central zone 1390 (70.7%). A few 20 (0.38%) did not specify in their response (Table 12).

Table 13: Access to video games

	Video games	No video Games	Occasionally	Did not specify	Total
Abia Central	398 (20.2%)	1316 (66.9%)	233 (11.8%)	20 (1.0%)	1967
Abia South	116 (6.7%)	1330 (77.1%)	279 (61.1%)	-	1725
Abia North	-	825 (44.1%)	700 (45.9%)	-	1525
	514 (9.85%)	3471 (66.53%)	1212 (23.23%)	20 (0.38%)	5217

No access to video games was the main response 3471 (66.53%), which was fairly spread out across the 3 zones: Abia Central 1316 (66.9%), Abia South 1330 (77.1%) and Abia North 825 (44.1%). 1212 (23.23%) had occasional access to video games with majority located in Abia North 700 (45.9%). 514 had access to video games which was spread out just to 2 zones: Abia Central 398 (20.2%) and Abia South 116 (6.7%). 20 (0.38%) from Abia central did not specify if had access or no access (Table 13).

Table 14: Access to Tablets

	Always	Never	Occasionally	Did not specify	Total
Abia Central	586 (29.8%)	1161 (59.0%)	200 (10.2%)	20 (1.0%)	1967
Abia South	78 (4.5%)	1351 (78.3%)	296 (17.2%)	-	1725
Abia North	13 (0.9%)	739 (48.5%)	773 (50.7%)	-	1525
	677 (12.98%)	3251 (62.32%)	1269 (24.32%)	20 (0.38%)	5271

Majority had no access to tablets 3251 (62.32%), which was fairly spread across all the 3 zones, Abia Central: 1161 (59.0%), Abia South: 1351 (78.3%) and Abia North 739 (48.5%). 1269 (24.32%) had occassional access to tablets, with Abia North being the highest 773 (50.7%), followed by Abia South 296 (17.2%) and Abia Central 200 (10.2%) the least. 677 (12.98%) always had access to tablets with majority being in Abia Central 586 (29.8%), closely followed by Abia South 78 (4.5%) and Abia North the least 13 (0.9%). 20 (0.38%) did not specify and this was from Abia central (Table 14).

Table 15: Access to TV

	Always	Never	Occasionally	Did not specify	Total
Abia Central	415 (21.1%)	37 (1.9%)	1495 (76.0%)	20 (1.0%)	1967
Abia South	327 (19.0%)	61 (3.5%)	1337 (77.5%)	-	1725
Abia North	670 (43.9%)	1 (0.1%)	854 (56.0%)	-	1525
	1412 (27.07%)	99 (1.90%)	3686 (70.65%)	20 (0.38%)	5217

Majority occasionally had access to TV, 3686 (70.65%), with majority in Abia Central 1495 (76.0%), followed closely by Abia South 1337 (77.5%) and Abia North 854 (56.0%). 1412 (27.07%) always have access to TV with majority in Abia North 670 (43.9%), followed by Abia Central 415 (21.1%) and South 327 (19.0%). Very few 99 (1.90%) did not have access to TV, mainly in Abia Central 37 (1.9%), Abia South 61 (3.5%) and Abia North 1 (0.1%). 20 (0.38%) participants did not specify and was from Abia Central (Table 15).

Table 16: Hours spent on the screen

	<1 hour	>1-3 hours	>3-7 hours	>7-11 hours	>11 hours	No specific amount of time	Total
Abia Central	470 (23.9%)	497 (25.3%)	-	504 (25.6%)	496 (25.2%)	-	1967
Abia South	107 (64.5%)	1388 (14.7%)	174 (10.1%)	19 (0.1%)	-	37 (20.8%)	1725
Abia North	20 (1.3%)	373 (24.5%)	595 (39.0%)	537 (35.2%)	-	-	1525
	597 (11.44%)	2258 (43.28%)	769 (14.74%)	1060 (20.32%)	496 (9.50%	37 (0.71%)	5217

The hours spent on these various screen, broken down into time zones was mostly spent between >1-3 hours: 2258 (43.28%), with Abia South being the majority 1388 (14.7%), Abia Central 497 (25.3%) with Abia North being the least 373(24.5%). >7-11 hours was spent by 1060 (20.32%) which was mainly in 2 zones respectively: Abia Central 504 (25.6%) and Abia North 537 (35.2%). 769 (14.74%) spent >3-7 hours with Abia North being most 595 (39.0%). 597 spent <1 hour with majority in Abia Central 470 (23.9%) and Abia South 107 (64.5%). 496 (9.50%) were heavy screen users spending >11 hours on screen time. These were from Abia central 496 (25.2%). 37 (0.71%) reported on specific amount of time and they were from Abia South (Table 16).

Table 17: Response based on previous sight test.

	No	Yes	Total
Abia Central	1741 (88.5%)	226 (11.5%)	1967
Abia South	1378 (79.9%)	347 (20.1%)	1725
Abia North	1109 (72.7%)	416 (27.3%)	1525
	4228 (81.04%)	989 (18.95%)	5217

Most of the students had never had an eye test, 4228 (81.04%) across all the geographical zones: Abia Central 1741 (88.5%), Abia South (79.9%) and Abia North 1109 (72.7%). Those who had had a sight test were 989 (18.95%) and reflected the same level across all 3 zones, 226 (11.5%) in Abia Central, 347 (20.1%) in Abia South and 416 (27.3%) in Abia North (Table 17).

Table 18: Location of previous eye check.

	Outreach	Eye Clinic	Other Locations	Total
Abia Central	93 (41.1%)	122 (54.0%)	11 (4.9%)	226
Abia South	276 (79.54%)	71 (20.46%)	-	347
Abia North	11 (0.7%)	395 (25.9%)	10 (2.40%)	416
	380 (38.42%)	588 (59.45%)	21 (2.12%)	989

The location of the various sight tests for those who had ever had one varied. It was either in an eye clinic, outreach or other unmentioned locations. Majority had been seen in an eye clinic 588 (59.45%), with Abia North highest 395 (25.9%), closely followed by Abia Central 122 (54.0%) and least being Abia South 71 (20.46%). 380/989 (38.42%) had their eyes tested in an outreach, Abia South the highest 276 (79.54%), followed by Abia Central 93 (41.1%) and the least 11 (0.7%). 21 (2.12%) had their eyes tested in other locations mainly in Abia Central 11 (4.9%) and Abia North 10 (2.4%) (Table 18).

Table 19: Those who wore glasses

	No	Yes	Total
Abia Central	1786 (90.8%)	181 (9.2%)	1967
Abia South	1678 (97.3%)	47 (2.72%)	1725
Abia North	1410 (92.5%)	115 (7.54%)	1525
	4874 (93.42%)	343 (6.57%)	5217

Only 343/5217 (6.57%) wore glasses: Abia Central 181 (9.2%), Abia North 115 (7.54%) and Abia South 47 (2.72%) but the majority 4874 (93.42%) did not : Abia Central; 1786 (90.8%), Abia South; 1678 (97.3%) and Abia North; 1410 (92.5%) (Table 19).

Table 20: Other Health conditions

	No	Yes	Total
Abia Central	1957 (99.5%)	10 (0.5%)	1967
Abia South	1707 (99.0%)	18 (1.0%)	1725
Abia North	1519 (99.6%)	6 (0.4%)	1525
	5183 (99.34%)	34 (0.65%)	5217

5183/5217 (99.34%) reported no other health conditions, this was the same across all three different zones respectively: Abia Central 1957 (99.5%), Abia South 1707 (99.0%) and Abia North 1519 (99.6%). Only 34 (0.65%) said yes to other health conditions. This showed that majority was in good health (Table 20).

Table 21: Those on medications

	No	Yes	Total
Abia Central	1937 (98.5%)	30 (1.5%)	1967
Abia South	1721 (99.8%)	4 (0.2%)	1725
Abia North	1509 (99.0%)	16 (1%)	1525
	5167 (99.04%)	50 (0.95%)	5217

When asked if they were on other medications, 5167/5217 (99.04%) responded no. This was reflected across the three zones: Abia Central 1937 (98.5%), Abia South 1721 (99.8%) and Abia North 1509 (99.0%). Very few participants were on any form of medication 50 (0.95%) and it's the same across all the zones (Table 21).

None of the participants smoked, they all responded no to the question.

Table 22: Those whose parents work.

	Yes	No	Total
Abia Central	948 (48.2%)	1019 (51.8%)	1967
Abia South	1657 (96.1%)	68 (3.9%)	1725
Abia North	1469 (96.3%)	56 (3.7%)	1525
	4074 (78.09%)	1143 (21.91%)	5217

The participants had majority of their parents working: 4074 (78.09%) which was spread out of the 3 geographical zones: Abia South; 1657 (96.1%), Abia North 1469 (96.3%) and Abia central; 949 (48.2%). 1143 (21.91%) responded no to having working parents with most response from Abia Central 1019 (51.8%) (Table 22).

Table 23 : Parents based on different jobs

	Civil servants/white collar jobs	Blue collar jobs	Total
Abia Central	841 (42.76%)	1126 (57.24%)	1967
Abia South	460 (26.67%)	1265 (73.33%)	1725
Abia North	323 (21.18%)	1202 (78.82%)	1525
	1624 (31.13%)	3593 (68.87%)	5217

3593/5217 (68.87%) had blue collar jobs, while 1624 (31.13%) were civil servants. The majority with blue collar jobs were evenly spread across all the 3 zones Abia South 1265 (73.33%), Abia Central 1126 (57.24%). Civil servants were less across all the 3 zones: Abia Central; 841 (42.76%), Abia South; 460 (26.67%) and Abia North; 323 (21.18%). The different jobs were mainly in 2 sectors either as white collar jobs such as being a civil servant or working in an office or blue collar jobs. These blue collar jobs were in different forms such as being self employed, skilled handy workers, traders etc (Table 23).

Table 24: Family eye history

	No	Yes	Total
Abia Central	259 (13.2%)	1708 (86.8%)	1967
Abia South	1722 (99.8%)	3 (0.2%)	1725
Abia North	1498 (98.2%)	27 (1.8%)	1525
	3479 (66.69%)	1738 (33.31%)	5217

Majority responded No to family eye history 3479 (66.69%). This was the same in Abia south 1722 (99.8%) and Abia north respectively 1498 (98.2%)but a few 1738 (33.31%) responded yes to family eye condition. However, this was mainly in Abia Central 1708 (86.8%). Those in Abia central were among grandparents 437 (25.6%), parents 961 (56.3%) and siblings 310 (18.1%) (Table 24).

Table 25 : Use of lenses by family members

	No	Yes	Total
Abia Central	259 (13.2%)	1708 (86.8%)	1967
Abia South	1714 (99.4%)	11 (0.63%)	1725
Abia North	698 (45.8%)	827 (54.2%)	1525
	2671 (51.20%)	2546 (48.80%)	5217

Across all study participants, the response was almost equal in both yes 2546 (48.80%) and no 2671 (51.20%) of lenses by family members. Across different zones, in Abia Central, majority 1708 (86.8%) said yes to use of lenses to family members. In Abia South, Many said no 1714 (99.4%) to the use of lenses by family members whereas in Abia North it was almost equally spread out with 827 (54.2%) responding to yes. This was spread out amongst dad 196 (12.9%), granddad 17 (1.1%), grandmum 90 (59%), mum 381 (25%), and siblings 143 (9.4%) (Table 25).

Table 26: Distribution of participants by refractive error

	Emmetropic	Hyperopic	Myopic	Astigmatism	Other eye pathology	Total
Abia Central	1320 (67.1%)	376 (19.1%)	271 (13.8%)	-	-	1967
Abia South	1420 (82.3%)	66 (3.8%)	238 (13.86%)	1 (0.1%)	-	1725
Abia North	1025 (82.3%)	153 (9.9%)	76 (5.0%)	162 (10.6%)	109 (7.19%)	1525
	3765 (72.17%)	595 (11.41%)	585 (11.21%)	163 (3.1%)	109 (2.09%)	5217

Most of the participants were all emetropic and it was the same across all the zones: Abia south 1420 (82.3%), Abia Central 1320 (67.1%) and Abia North 1025 (82.3%). The rate of myopia 585 (11.21%) and hyperopia 595 (11.41%) was almost the same across the whole study group. Astigmatism was the least 163 (3.1%). In refractive errors, In Abia central, hyperopia 376 (19.1%) was more than myopia 271 (13.8%); In Abia South, myopia 238 (13.86%) was more prevalent while in Abia North, astigmatism 162 (10.6%) , hyperopia 153 (9.9%) and other eye pathology 109 (7.19%) was fairly spread out with myopia 76 (5.0%) being the least (Table 26).

Table 27 Different levels of myopia

	Low Myopia (≤ 3.00D)	Moderate Myopia (>-3.00 to -6.00D)	High Myopia (>6.00D)	Total
Abia Central	224 (82.7%)	47 (17.3%)	-	271
Abia South	187 (78.6%)	45 (18.9%)	6 (2.5%)	238
Abia North	61 (80.3%)	8 (10.5%)	7 (9.2%)	76
	472 (80.68%)	100 (17.09%	13 (2.22%)	585

472 (80.68%) had low myopia, closely followed by moderate myopia 100 (17.09%) and high myopia was the least 13 (2.22%). In Abia Central, Abia South and Abia North, low myopia was more prevalent 224 (82.7%, 187 (78.6%) and 61 (80.3%) respectively (Table 27).

Test of statistics

Refractive error and gender

Table 28 : Table for statistical analysis and test for hypothesis by gender of all the senatorial zones

	Anisometropia		Astigmatism		Hyperopia		Myopia		Emmetropia		Other eye pathology		Total
	F	M	F	M	F	M	F	M	F	M	M	F	
Abia Central	-	-	-	-	193	183	146	125	688	632	-	-	1967
Abia South	-	-	2	1	25	41	136	870	707	713	-	-	1725
Abia North	1	1	91	71	88	63	40	36	575	450	71	38	1525
													5217

The P-value of the chi-square test is 1.52×10^{-75}, which is less than 0.05. Thus, the null hypothesis is rejected. There is a statistically significant effect of gender on the diagnosis of refractive errors (Table 28).

The effect size using Cramer's V= 0.245 showed that gender has a medium effect size on the diagnosis of the refractive errors; anisometropia, astigmatism, hyperopia, myopia, emmetropia, and other eye pathologies (Fig 5).

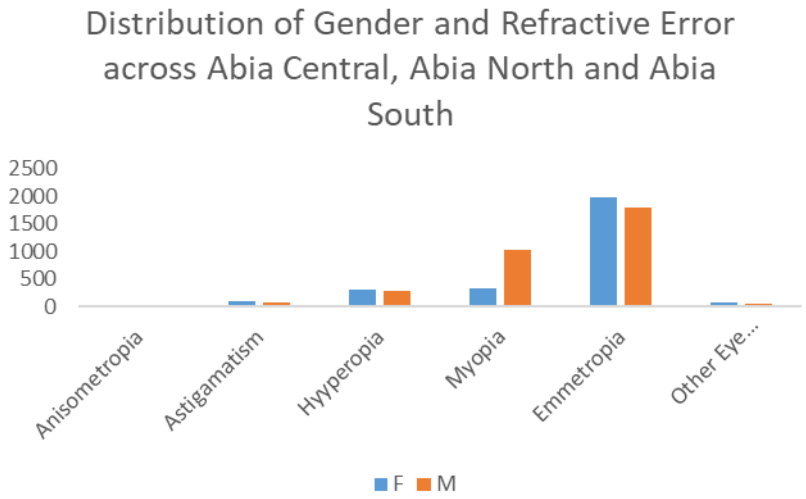


Fig 5: Graph showing the distribution of refractive errors in Abia state

On analysis in sub groups, the results were different. **In Abia Central** (Fig 6) there was no significant difference. The p-value of 0.810, is greater than the significance value of 0.05 indicated that we failed to reject the null hypothesis. The null hypothesis stated that there was no significant relationship between gender and refractive errors

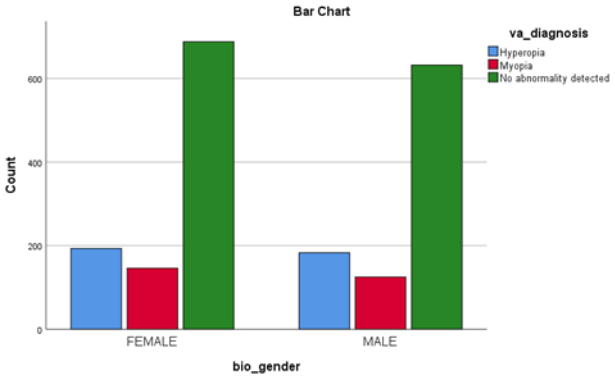


Figure 6: A plot showing gender and refractive errors for Abia Central

For Abia South (Fig 7), From the p-value of 0.036, which is less than 0.05 defines that we rejected the null hypothesis. The alternate hypothesis was accepted. There was a significant relationship between gender and refractive errors.

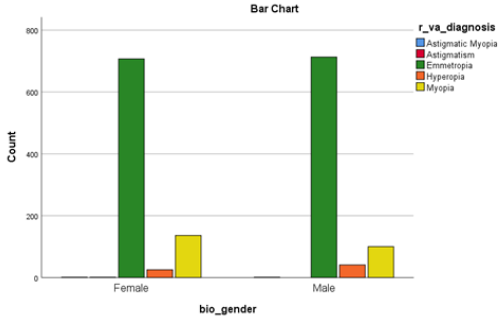


Figure 7: A plot showing gender and refractive errors for Abia South

In Abia North, Female students recorded more myopic cases than the male students The p-value of 0.545, which is greater than 0.05 defines that we failed to reject the null hypothesis. Thus, the null hypothesis indicated that there was no significant relationship between gender and refractive errors/ocular pathology (Fig 8).

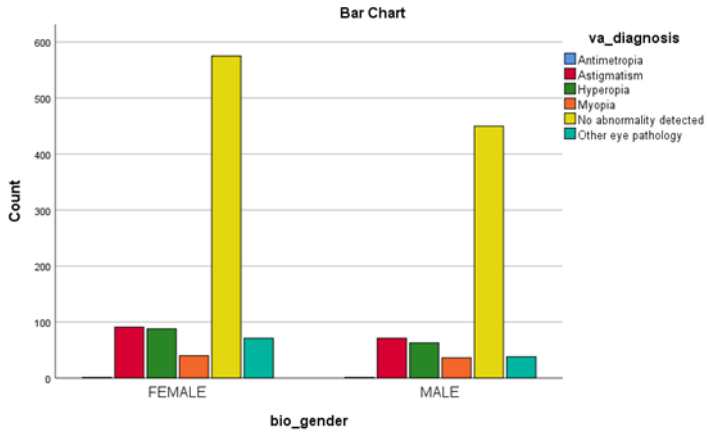


Fig 8: A plot showing gender and refractive errors for Abia North.

Refractive error and age group

Table 29: Distribution of refractive error across Abia State by age group

	Anisometropia	Astigmatism	Hyperopia	Myopia	Emmetropia	Other Eye Pathology	Total
< 5 years	0	0	13	4	46	12	75
5-11 years	0	90	337	195	1788	56	2466
> 11-17 years	2	9	178	288	1684	28	2189
> 17-25 years	0	64	65	98	247	13	487
	2	163	593	585	3765	109	5217

The P-value of the chi-square test is 2.00 x 10^{-83}, which is less than 0.05. Thus, the null hypothesis is rejected. There is a statistically significant effect of age group on the diagnosis of refractive errors (Table 29).

The effect size using Cramer's V= 0.17shows that age group has a weak effect on the diagnosis of the refractive errors; anisometropia, astigmatism, hyperopia, myopia, emmetropia, and other eye pathologies. There is a small relationship between age group and refractive errors.

Analysing in different zones, for Abia Central (Fig 8), there was a significant relationship: The p-value of 0.00, which is less than 0.05 defined that we rejected the null hypothesis. The alternate hypothesis was accepted. There is a significant relationship between age group and refractive errors

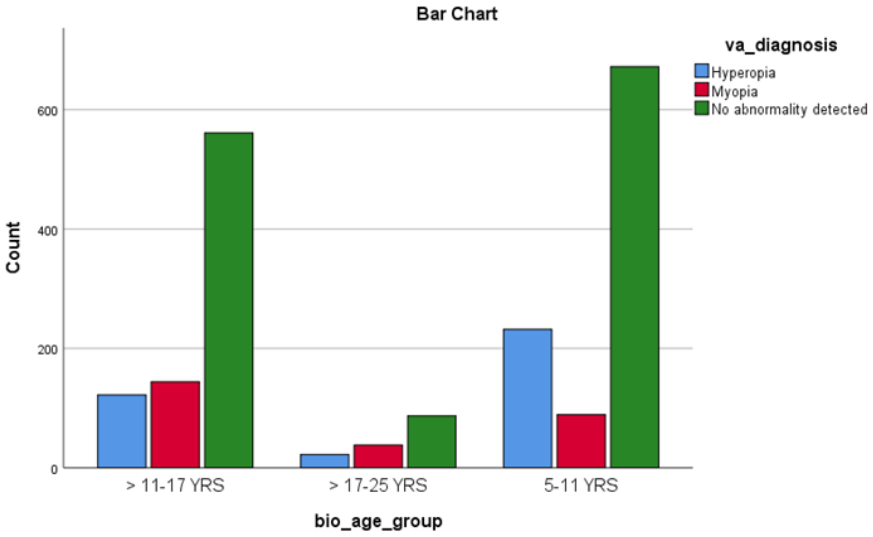
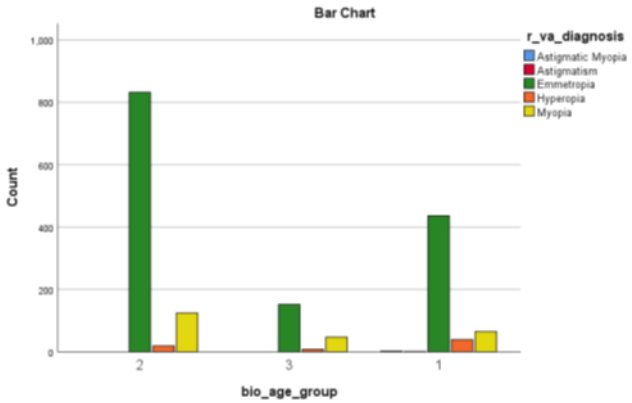


Figure 9 : A plot showing gender and age groups, Abia Central

From the figure above, age group (>11-17yrs) had the most myopic cases followed by (5-11yrs) and (>17-25yrs) (Figure 9).

Abia South (Fig 10), The significant value of 0.000 which was less than 0.05 indicated that we rejected the null hypothesis. There was a relationship between age group and diagnosis.



5-11YRS >11-17YRS >17-25YRS

Figure 10: Age distribution of refractive errors, Abia South

Abia North, Myopia was more prevalent in age group 5-11Yrs than other age groups (Fig 11). The significant value of 0.000 which was less than 0.05 indicated that we rejected the null hypothesis. There was a relationship between age group and diagnosis.

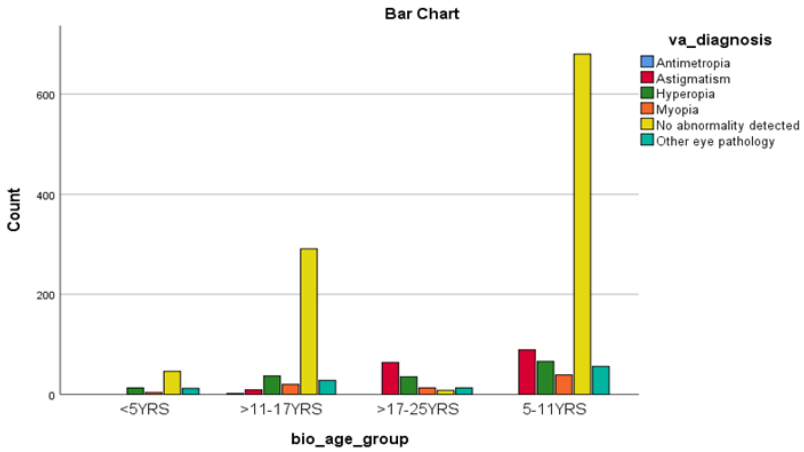


Figure 11: Refractive error by age group, Abia North.

Refractive error and level of education

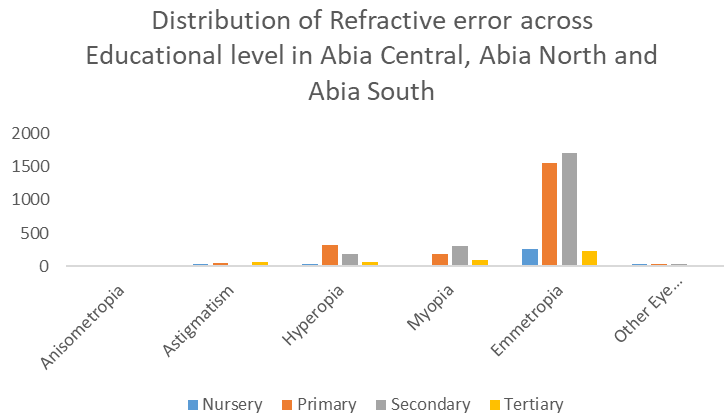


Fig 12: Distribution of refractive error according to educational levels across the zones in Abia State

The P-value of the chi-square test is 1.71 x 10^{-99}, which is less than 0.05. Thus, the null hypothesis is rejected. There is a statistically significant effect of educational level on the diagnosis of refractive errors (Fig 12).

The effect size using Cramer's V = 0.18 shows that age group has a weak effect on the diagnosis of the refractive errors; anisometropia, astigmatism, hyperopia, myopia, emmetropia, and other eye pathologies. There is a small relationship between level of education and refractive errors.

Abia Central: The p-value of 0.00, which is less than 0.05 defines that we reject the null hypothesis. The alternate hypothesis is accepted. There is a significant relationship between education level and refractive errors (Fig 13).

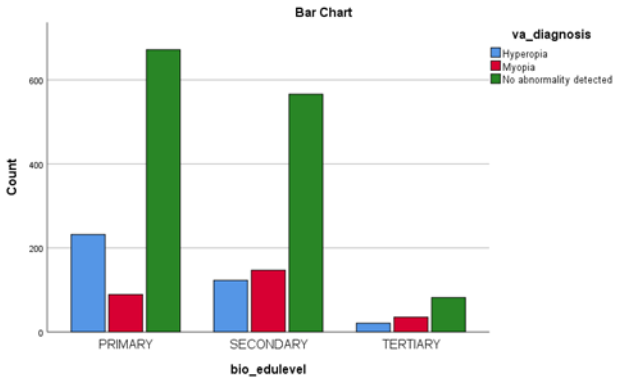
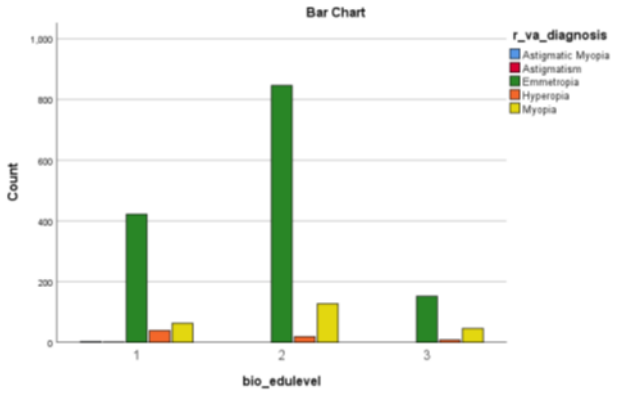


Figure 13: A plot showing refractive errors and different levels of education, Abia Central.

Figure 13 above showed that those in secondary school had more cases of myopia, followed by primary school students and tertiary institution students.

Abia South (Fig 14): The p-value of 0.00 which is less than the significant value of 0.05 indicates we reject the null hypothesis. There is relationship between educational level and diagnosis.



PRIMARY SECONDARY TERTIARY

Fig 14: A plot showing refractive errors and different levels of education, Abia South.

From the figure above, those in secondary school had more myopic cases, followed by primary students and tertiary institution (Fig 14).

Abia North (Fig 15): The p-value of 0.00 which is less than the significant value of 0.05 indicates we reject the null hypothesis. There is relationship between educational level and diagnosis.

From the graph below, those in secondary school had more myopic cases, followed by primary students and nursery. There is relationship between educational level and diagnosis.

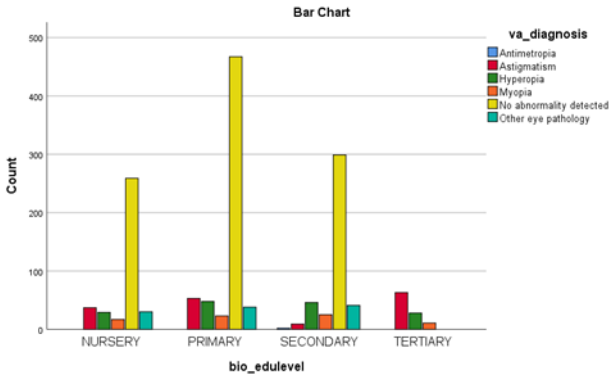


Fig 15: A plot showing refractive errors and different levels of education, Abia North.

Analysis by school type

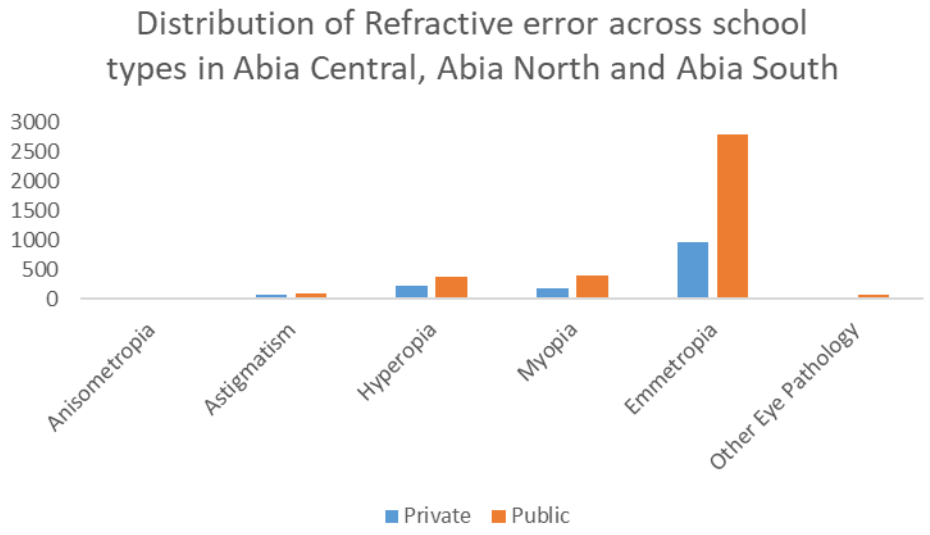


Fig 16: A plot showing refractive errors and school types, Abia State.

The P-value of the chi-square test is 8.72 x 10^{-13}, which is less than 0.05. Thus, the null hypothesis is rejected. There is a statistically significant effect of school type on the diagnosis of refractive errors.

The effect size using Cramer's V = 0.112 shows that school type – public and private has a weak effect on the diagnosis of the refractive errors; anisometropia, astigmatism, hyperopia, myopia, emmetropia, and other eye pathologies. There is a small relationship between school types and refractive errors (Fig 16).

Abia central, The p-value of 0.262, which is greater than the significance value of 0.05 indicates that we fail to reject the null hypothesis. The null hypothesis states that there is no significant relationship between school type and refractive errors (Fig 17).

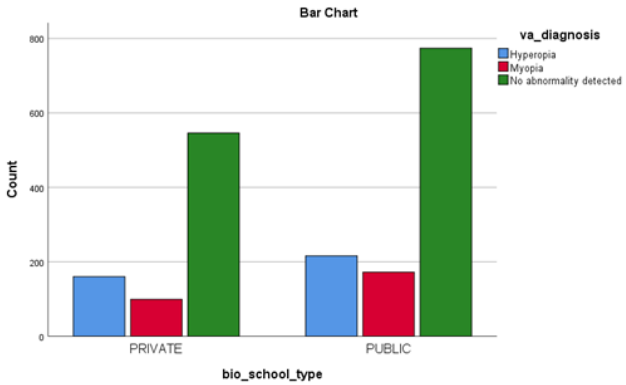


Figure 17: A plot showing refractive errors and different types of schools, Abia Central.

Although we see from the figure above that those who attended public schools had more myopic cases than students in private school but statistically, it is insignificant (Figure 17).

Abia south: The p-value of 0.021, which is less than 0.05, indicates that we reject the null hypothesis. There is relationship between occurrence of refractive errors and school type.(Fig 18)

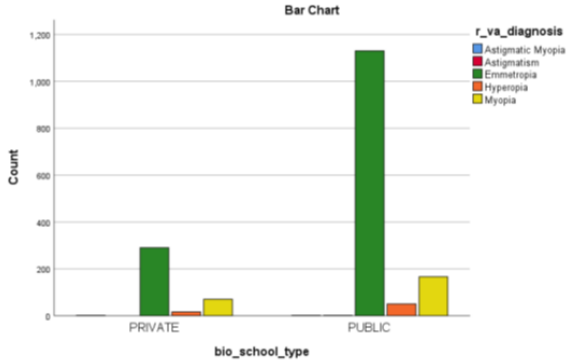


Figure 18: A plot showing refractive errors and different types of schools, Abia South.

From the figure above, it shows that those who attended public school had more myopic cases that students in private school (Fig 18).

Abia North: Myopia is more in public schools than private schools. Abia south: The p-value of 0.000, which is less than 0.05, indicates that we reject the null hypothesis. There is relationship between occurrence of refractive errors and school type.(Fig 19)

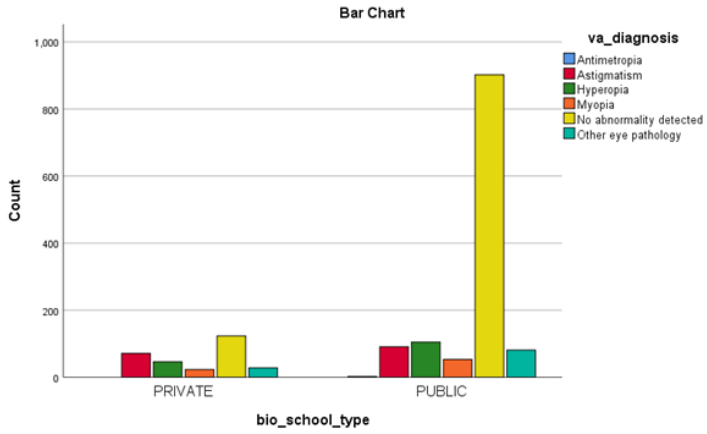


Figure 19: A plot showing refractive errors and different types of schools, Abia North.

Location of school and refractive errors.

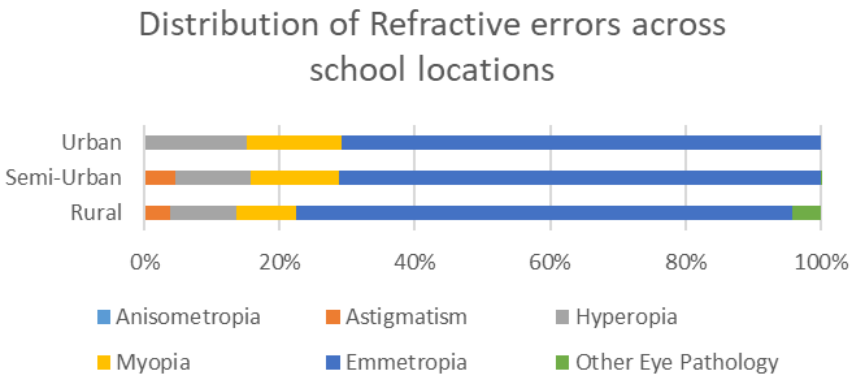


Figure 20: A plot showing refractive errors and location of schools in Abia State.

The P-value of the chi-square test is 4.97 x 10^{-39}, which is less than 0.05. Thus, the null hypothesis is rejected. There is a statistically significant effect of school type on the diagnosis of refractive errors (Fig 20).

The effect size using Cramer's V= 0.14 shows that location of school – rural, semi-urban, and urban has a weak effect on the diagnosis of the refractive errors; anisometropia, astigmatism, hyperopia, myopia, emmetropia, and other eye pathologies. There is a small relationship between location of school and refractive errors.

Abia Central: The p-value of 0.106, which is greater than the significance value of 0.05 indicates that we fail to reject the null hypothesis. The null hypothesis states that there is no significant relationship between school location and refractive errors (Fig 21).

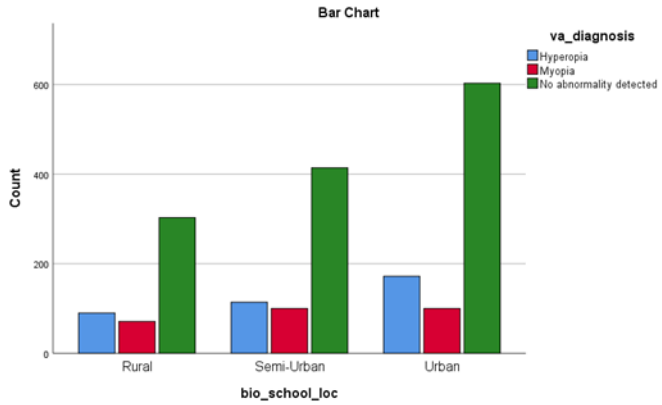


Figure 21: A plot showing refractive errors and locations of schools, Abia Central

Abia South: The p-value of 0.001 which is less than 0.05, indicates that we reject the null hypothesis. The alternate hypothesis states that there is a relationship between school location and refractive error occurrence (Fig 22).

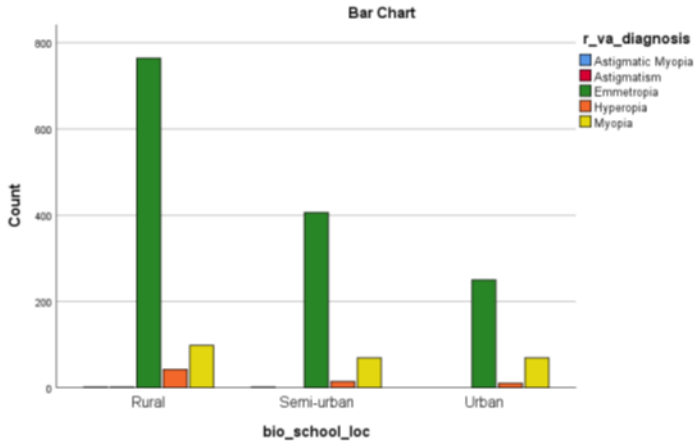


Figure 22: A plot showing refractive errors and locations of schools, Abia South

From the figure above, it shows students in the rural area had more myopic cases, followed by students in the semi-urban and urban area.

Abia North: There is a relationship between myopia and school location being 59 in rural amd 17 in semi Urban areas causing a higher prevalence in rural areas than in urban areas.

The p-value of 0.000 which is less than 0.05, indicates that we reject the null hypothesis. The alternate hypothesis states that there is a relationship between school location and refractive error occurrence (Fig 23)

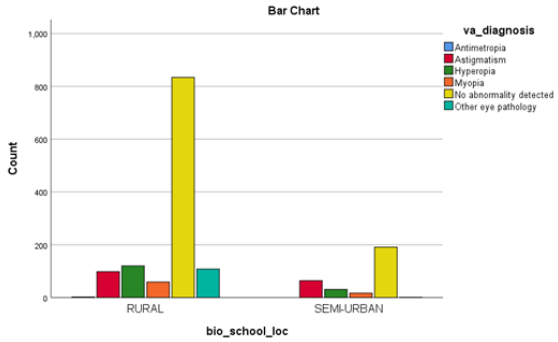


Figure 23: A plot showing refractive errors and locations of schools, Abia North

Refractive error and study time

Table 30: A Table showing refractive errors and study time, Abia State

Long Study Time	Anisometropia	Astigmatism	Hyperopia	Myopia	Emmetropia	Other Eye Pathology	Total
No	2	62	280	175	1434	53	2006
Yes	0	101	313	410	2331	56	3211
	2	163	593	585	3765	109	5217

The P-value of the chi-square test is 1.17 x 10^{-8}, which is less than 0.05. Thus, the null hypothesis is rejected. There is a statistically significant effect of long study time on the diagnosis of refractive errors (Table 30).

The effect size using Cramer's V= 0.09 shows that long study time has negligible effect on the diagnosis of the refractive errors; anisometropia, astigmatism, hyperopia, myopia, emmetropia, and other eye pathologies. There is a negligible association between length of study time and refractive errors.

Abia Central: The p-value of 0.000, which is less than 0.05 defines that we reject the null hypothesis. The alternate hypothesis is accepted. There is a significant relationship between amount of study time and refractive errors (Figure 24).

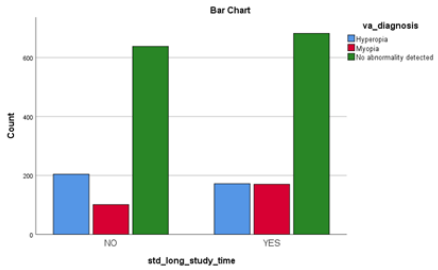


Figure 24: A plot showing refractive errors and effect of study time, Abia Central

The p-value of 0.000, which is less than 0.05 defines that we reject the null hypothesis. The alternate hypothesis is accepted. There is a significant relationship between amount of time spent studying at school daily and refractive errors (Figure 25).

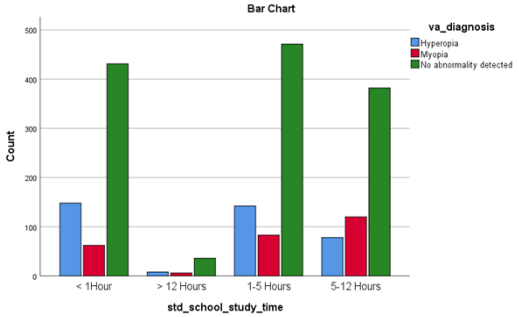


Figure 25: A plot showing refractive errors and hours of study, Abia Central

Abia South: The figure 26 below shows that those who indicated yes to long study time had more myopic cases than students who responded no. The p-value of 0.271 which is greater than the significant value of 0.05 indicates there is no relationship between study time and diagnosis of refractive error. We fail to reject the null hypothesis.

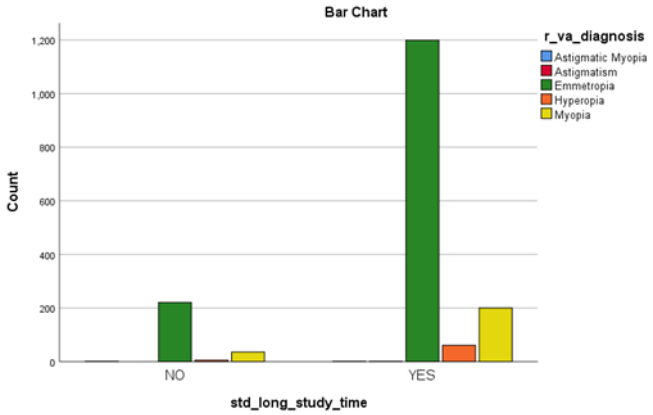


Figure 26: A plot showing refractive errors and effect of study time, Abia South

Abia North: The p-value of 0.757, which is greater than the significant value of 0.05, indicates there is no relationship between study time and diagnosis of refractive error. We fail to reject the null hypothesis (Fig 27 & 28).

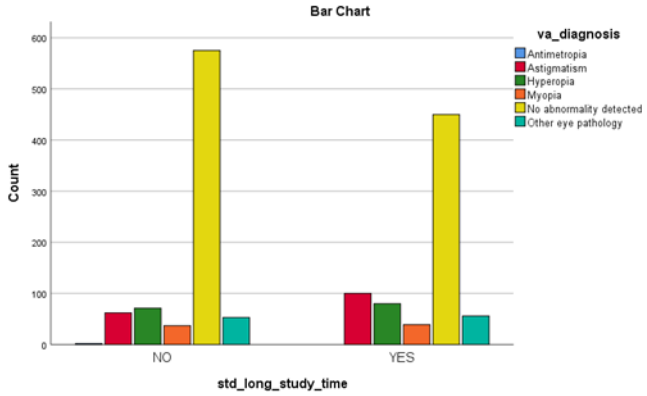


Figure 27: A plot showing refractive errors and effect of study time, Abia North

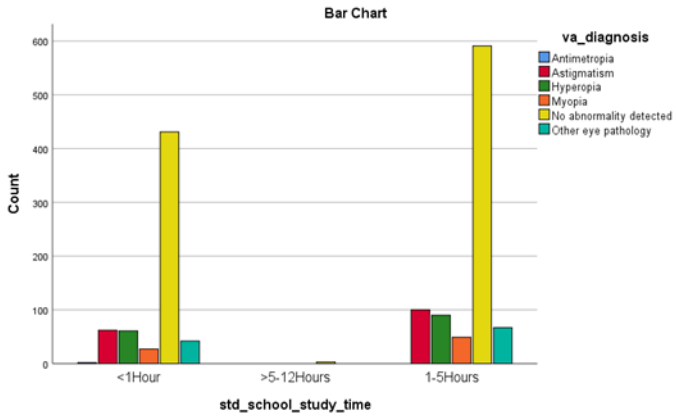


Figure 28: A plot showing refractive errors and hours of study, Abia North

Time spent on homework and refractive error

Abia State: The P-value of the chi-square test is 2.782 x 10^{-51}, which is less than 0.05. Thus, the null hypothesis is rejected. There is a statistically significant effect of assignment time, time spent on homework on the diagnosis of refractive errors (Fig 29).

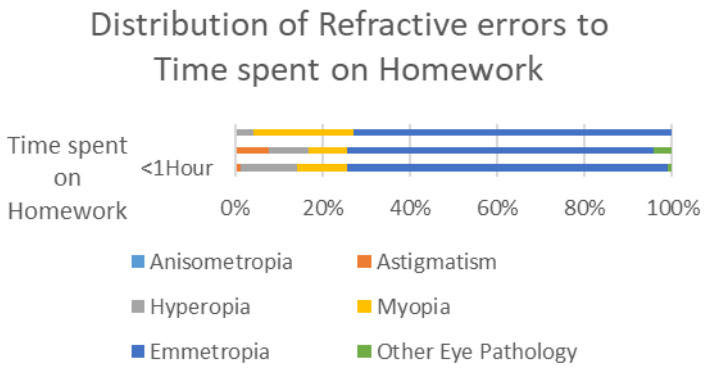


Figure 29: A plot showing refractive errors and homework time, Abia State

The effect size using Cramer's V= 0.16 shows that time spent on homework has weak effect on the diagnosis of the refractive errors; anisometropia, astigmatism, hyperopia, myopia, emmetropia, and other eye pathologies. There is a small association between effect of assignment, time spent on homework and refractive errors.

Abia Central: The p-value of 0.524, which is greater than the significance value of 0.05 indicated that we failed to reject the null hypothesis. The null hypothesis stated that there was no significant relationship between time spent outdoors and refractive errors (Fig 30).

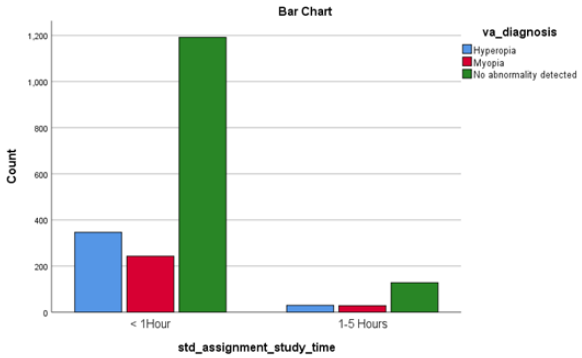


Figure 30: A plot showing refractive errors and homework time, Abia Central

Abia South: The p-value of 0.000, which is less than 0.05 defines that we reject the null hypothesis. The alternate hypothesis is accepted. There is a significant relationship between amount of time spent on homework daily and refractive errors (Fig 31).

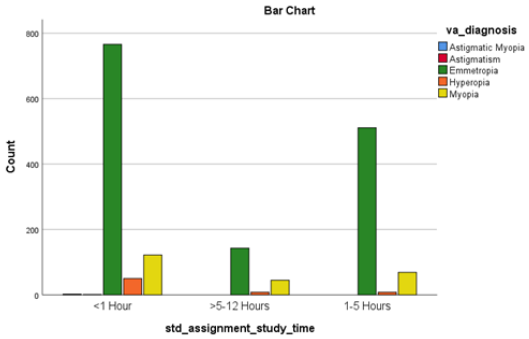


Figure 31: A plot showing refractive errors and homework time, Abia South

Abia North: The p-value of 0.000, which is less than 0.05 defines that we reject the null hypothesis. The alternate hypothesis is accepted. There is a significant relationship between amount of time spent on homework daily and refractive errors (**Fig 32**)

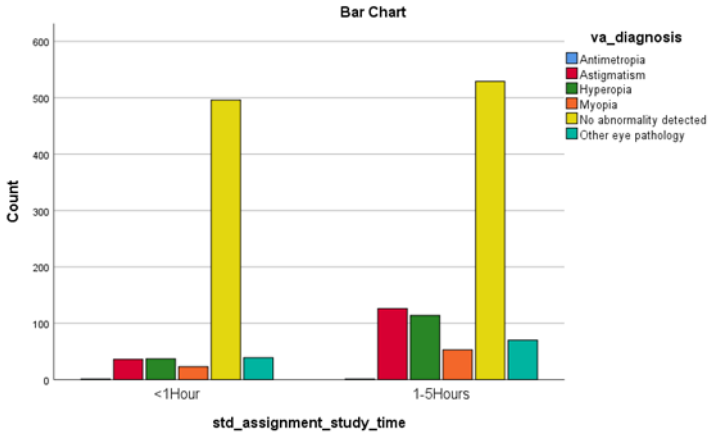


Figure 32: A plot showing refractive errors and homework time, Abia North

Refractive error and time spent outside

Abia State: The P-value of the chi-square test is 1.91 x 10^{-11}, which is less than 0.05. Thus, the null hypothesis is rejected. There is a statistically significant effect of assignment time, time spent on homework on the diagnosis of refractive errors (Fig 33).

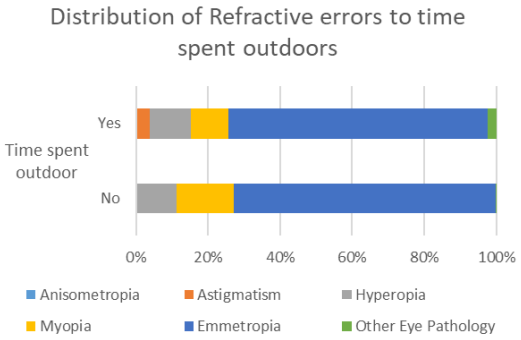


Figure 33: A plot showing refractive errors and time spent outside, Abia State.

The effect size using Cramer's V = 0.11 shows that time spent on homework has weak effect on the diagnosis of the refractive errors; anisometropia, astigmatism, hyperopia, myopia, emmetropia, and other eye pathologies. There is a small association between effect of time spent outdoor and refractive errors.

Abia Central: The p-value of 0.571, which is greater than the significance value of 0.05 indicated that we failed to reject the null hypothesis. The null hypothesis stated that there was no significant relationship between time spent outdoors and refractive errors (figure 34).

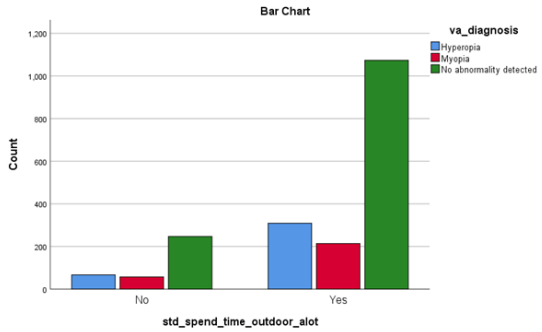


Figure 34: A plot showing refractive errors and time spent outside, Abia Central.

Abia South: The p-value of 0.108, which is greater than the significance value of 0.05 indicated that we failed to reject the null hypothesis. The null hypothesis stated that there was no significant relationship between time spent outdoors and refractive errors (figure 35).

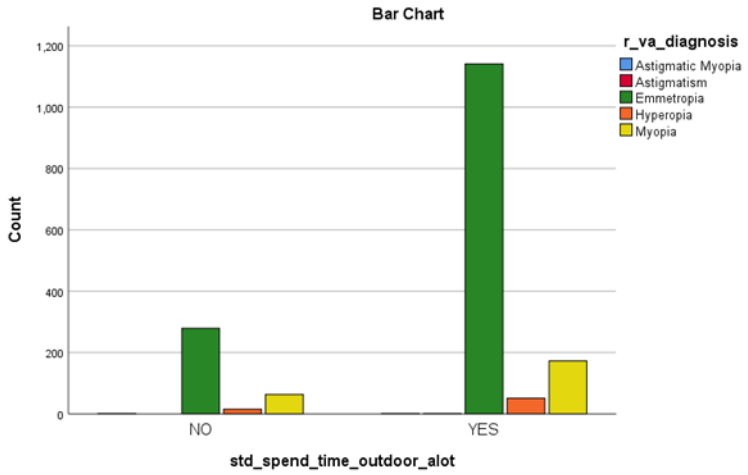


Figure 35: A plot showing refractive errors and time spent outside, Abia South.

Abia North: 74 subjects who had access to screen time had myopia while 2 subjects who had no access to screen time also had myopia. The p-value of 0.304, which is greater than the significance value of 0.05 indicated that we failed to reject the null hypothesis. The null hypothesis stated that there was no significant relationship between time spent outdoors and refractive errors (figure 36).

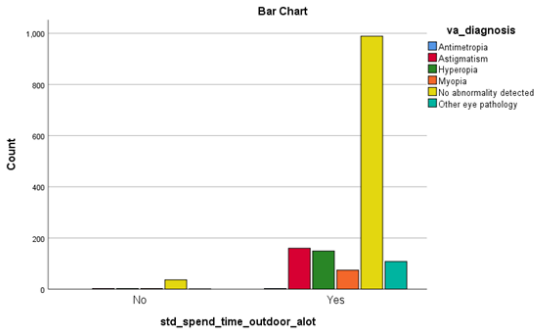


Figure 36: A plot showing refractive errors and time spent outside, Abia South.

Lighting and refractive errors

Abia State: The P-value of the chi-square test is 1.396 x 10^{-18}, which is less than 0.05. Thus, the null hypothesis is rejected. There is a statistically significant effect of study lighting type on the diagnosis of refractive errors (Fig 37).

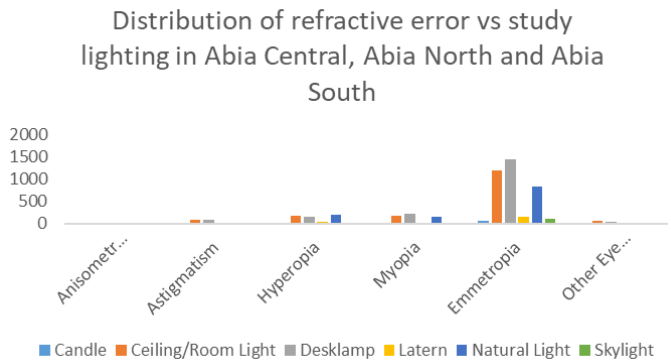


Figure 37: A plot showing refractive errors and lighting used, Abia State.

The effect size using Cramer's V= 0.07 shows that time spent on study lighting type has negligible effect on the diagnosis of the refractive errors; anisometropia, astigmatism, hyperopia, myopia, emmetropia, and other eye pathologies. There is a negligible association between study lighting type and refractive errors.

Abia central: The P-value of the chi-square test is 0.515 which is more than 0.05. Thus, the null hypothesis is accepted. There is no statistically significant effect of study lighting type on the diagnosis of refractive errors (Fig 38).

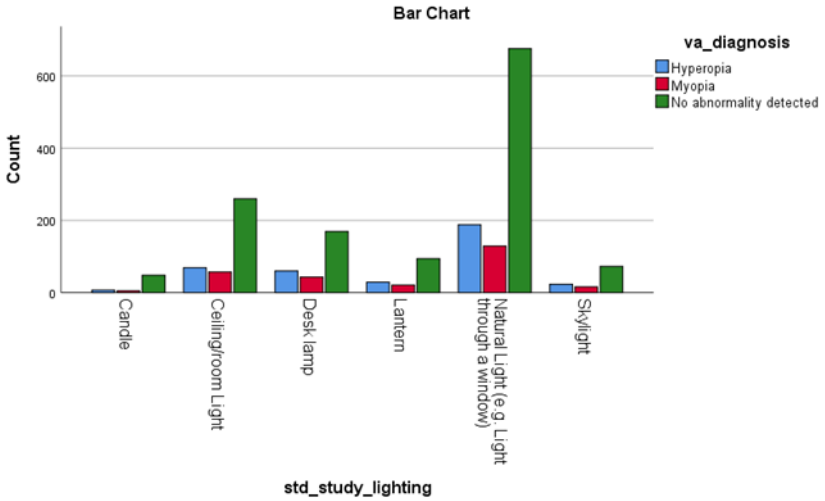


Figure 38: A plot showing refractive errors and lighting used, Abia Central.

Abia North: From the figure above, students who reported using desk lamp to read, had more myopic cases followed by those who used ceiling/room light (Fig 39).

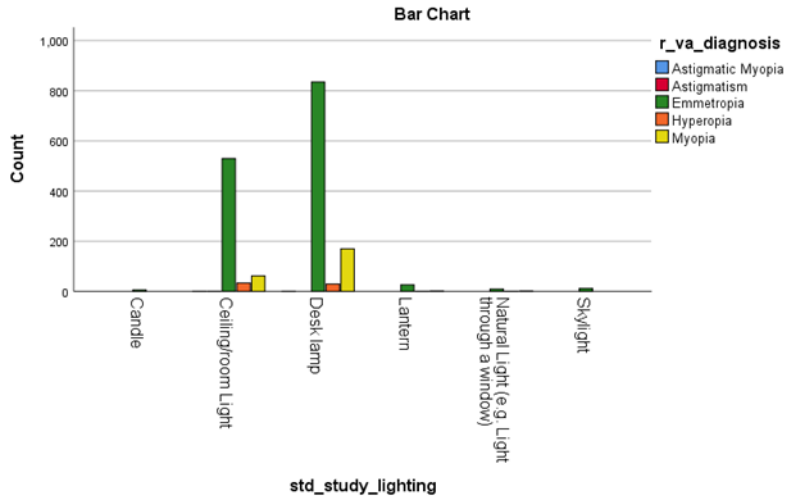


Figure 39: A plot showing refractive errors and lighting used, Abia North .

The p-value of 0.131 which is greater than the significance value 0.05 indicates that we fail to reject the null hypothesis. The null hypothesis states that there is no significant relationship between study lightning and refractive errors.

Abia South: 46 Subjects who used ceiling light had myopia followed by 16 subjects who used desklamp ,12 subjects using natural lightening and 2 subjects using a lantern.

The P-value of the chi-square test is 0.000 which is less than 0.05. Thus, the null hypothesis is rejected. There is a statistically significant effect of study lighting type on the diagnosis of refractive errors (Fig 40).

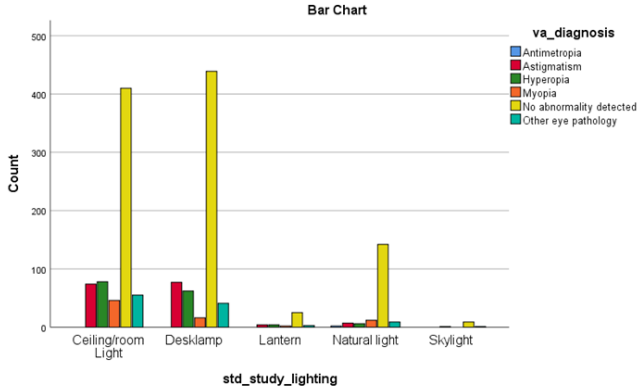


Figure 40: A plot showing refractive errors and lighting used, Abia South .

Screen time and refractive errors

Abia South: The P-value of the chi-square test is 1.289 x 10^{-87}, which is less than 0.05. Thus, the null hypothesis is rejected. There is a statistically significant effect of screen time on the diagnosis of refractive errors.

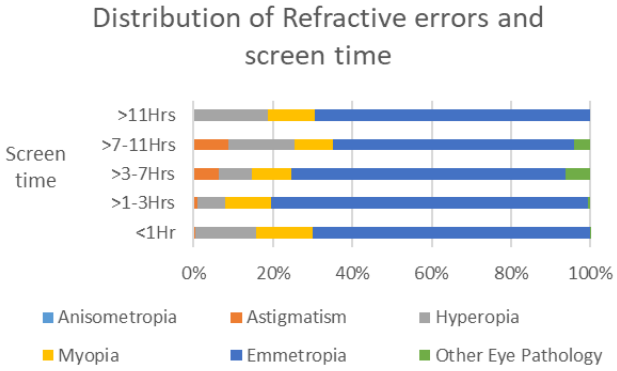


Figure 41: A plot showing refractive errors and screen time use in Abia State.

The effect size using Cramer's V= 0.15 shows that screen time has a weak effect on the diagnosis of the refractive errors; anisometropia, astigmatism, hyperopia, myopia, emmetropia, and other eye pathologies. There is a small association between screen time and refractive errors.

Abia Central: The p-value of 0.514, which was greater than the significance value of 0.05 indicated that we failed to reject the null hypothesis. The null hypothesis stated that there was no significant relationship between access to screen time and refractive errors (Fig 42).

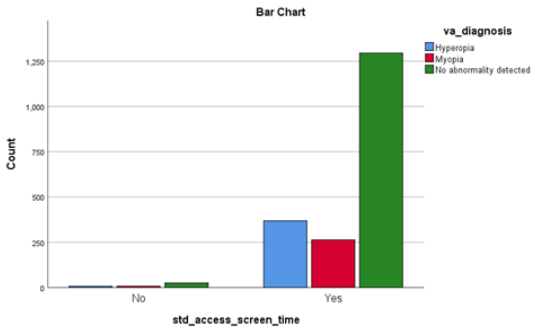


Figure 42: A plot showing refractive errors and effect of access to screen time, Abia Central

The p-value of 0.470, which was greater than the significance value of 0.05 indicated that we failed to reject the null hypothesis. The null hypothesis stated that there was no significant relationship between number of hours on screen time and refractive errors (Figure 43).

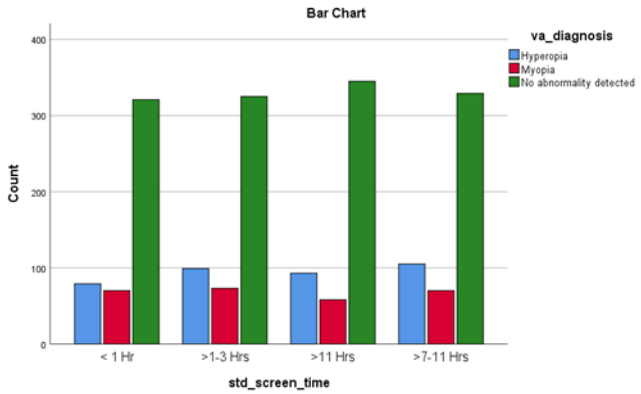


Figure 43: A plot showing refractive errors and effect of screen time, Abia Central

Abia South: From the figure above, students who had access to screen time had more myopic cases than those who don't have access to screen time (fig 44).

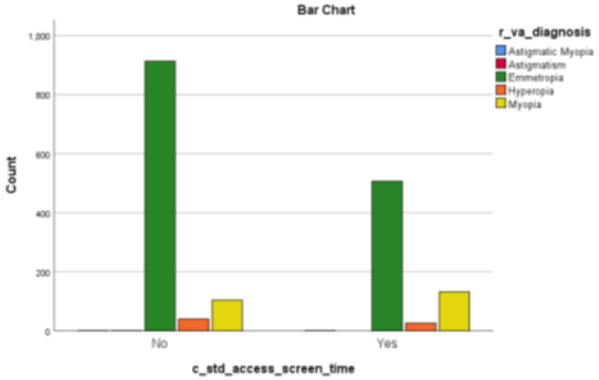


Figure 44: A plot showing refractive errors and effect of screen time, Abia South

The p-value of 0.000, which is less than 0.05, indicates we reject the null hypothesis. The alternate hypothesis states that there is a relationship between screen time and refractive error diagnosis.

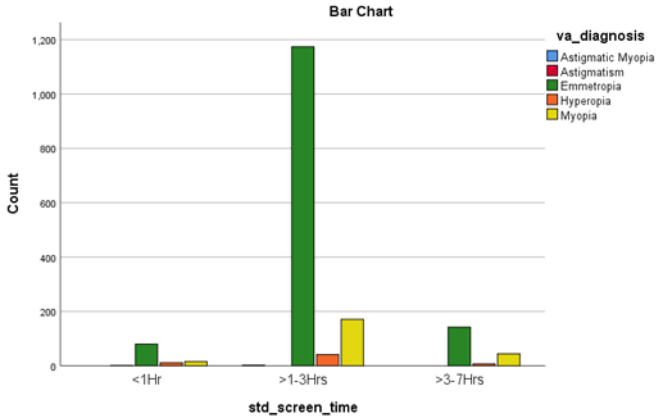


Figure 45: A plot showing refractive errors and effect of screen time, Abia South

The p-value of 0.000 which is less than 0.05 indicates that the null hypothesis is rejected. The alternate hypothesis states that there is a relationship between amount of screen time to the diagnosis of refractive errors (|Fig 45).

Abia North: The p-value of 0.000 which is less than 0.05 indicates that the null hypothesis is rejected. The alternate hypothesis states that there is a relationship between amount of screen time to the diagnosis of refractive errors (Fig 46, 47)

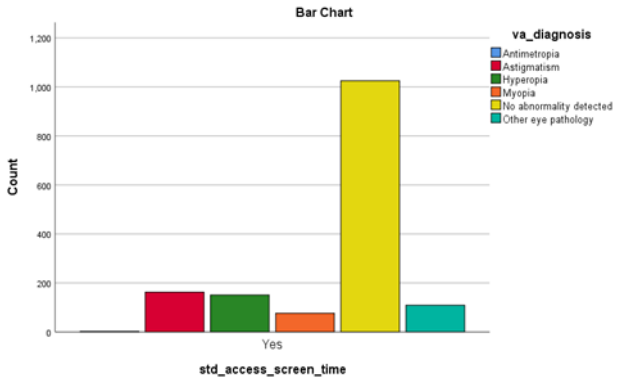


Figure 46: A plot showing refractive errors and effect of screen time, Abia North

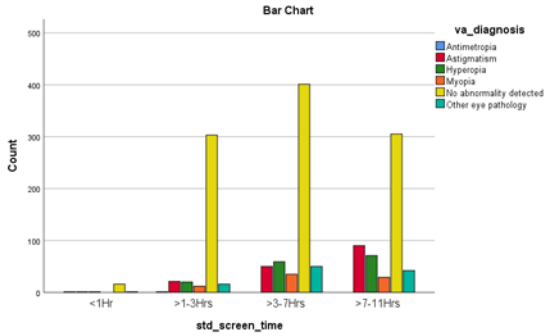


Figure 47: A plot showing refractive errors and effect of screen time, Abia North

Refractive error and occupation of parent

Abia State: The P-value of the chi-square test is 1.51 x 10^{-5}, which is less than 0.05. Thus, the null hypothesis is rejected. There is a statistically significant effect of parent's occupation class on the diagnosis of refractive errors (fig 48).

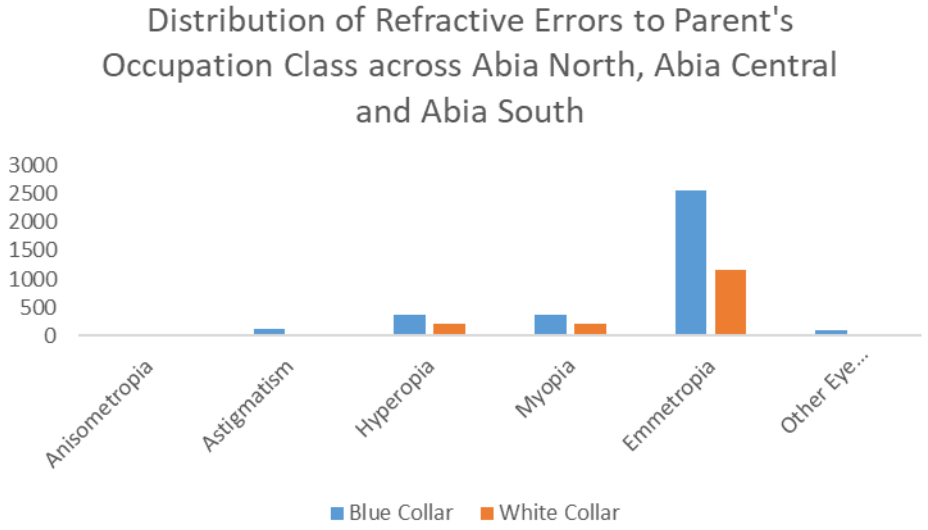


Figure 48: A plot showing the types of occupation of parents, Abia State

The effect size using Cramer's V= 0.08 shows that parents occupation class has a very weak effect on the diagnosis of the refractive errors; anisometropia, astigmatism, hyperopia, myopia, emmetropia, and other eye pathologies. There is a negligible association between parents occupation class to diagnosis of refractive errors.

Abia Central: The p-value is 0.742 which is greater than 0.05, thus we fail to reject the null hypothesis. Parents' occupation is not associated with refractive errors.

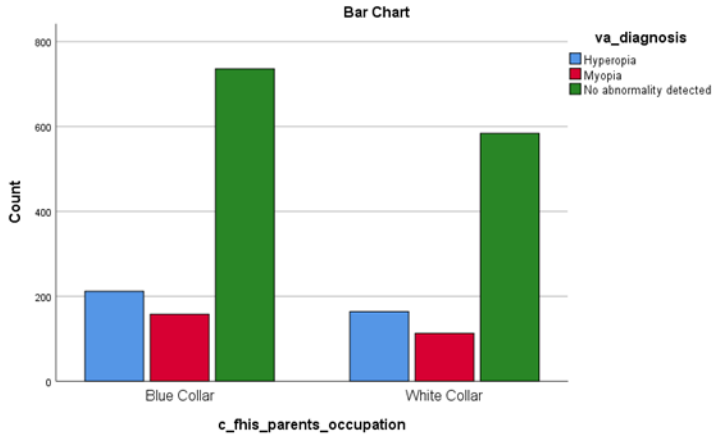


Figure 49: A plot showing the types of occupation of parents, Abia central

Abia North: The p-value is 0.859 which is greater than 0.05, thus we fail to reject the null hypothesis. Parents' occupation is not associated with refractive errors (Fig 50).

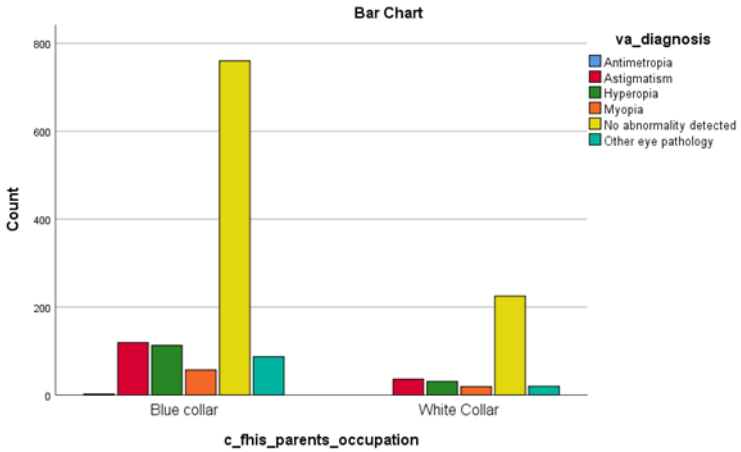


Figure 50: A plot showing the types of occupation of parents, Abia North.

Abia South: The p-value of 0.003 is less than 0.05. Therefore, we reject the null hypothesis. The alternate hypothesis states that there is a significant relationship between parent's occupation's class to diagnosis of refractive errors (Fig 51).

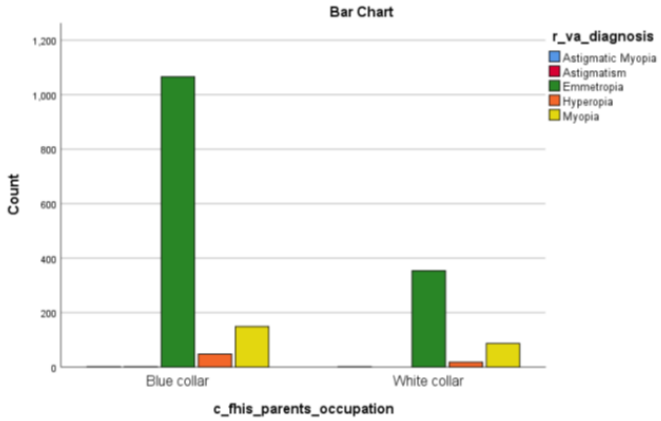


Figure 51: A plot showing the types of occupation of parents, Abia South.

IV. Discussion

The population size studied was a good size. There was a statistically significant effect of gender and age groups on refractive error in this study (Table 28 & 29), though this effect varied across the different sub-groups (Fig 6-11). Cramers effect on size showed it was a medium effect. Different studies have had different results. Wajuihian and Mashige (2021) retrospectively analysed some clinic records in patients between 6-85 years, and found males more myopic while females were more hyperopic and astigmatic. *Onu et al .,* (2014), found the distribution was almost similar across all the gender. Khoshhal *et al.,* (2020) in a systematic analysis of similar studies done in the middle east, found similar results which varied across different age groups. Adebusoye et al., (2024) in his systematic review of the population study in Nigeria found that there was high prevalence of refractive errors among Nigerian children (Adebusoye *et al.,* 2024). A cochrane review by Evans et al., (208) showed screening as a common way of checking for refractive errors in developing countries (Evans et al., 2018).

The study showed that there was significant effect on the diagnosis of refractive error based on the level of education p= 1.71×10^{-99} (Fig 12-15). This effect was small based on Cramers effect. For those in the primary schools, hyperopia followed closely by myopia was more prevalent. Those in secondary school were slighly more myopic and that was the same trend for those in tertiary education. This result was the same across all the 3 geographical zones of the state with p=0.00. Sheeladevi *et al.,* (2018) found significant level of refractive errors in children in secondary and primary schools in india (Sheeladevi *et al.,* (2018).

Analyis done by whether it was a public or private school, showed a significant relationship between school type and refractive error, p= 8.72×10^{-13} but Cramers effect V=0.112 showed a weak relationship. Both Myopia and hyperopia was more common in public schools in Abia State compared to private schools (Fig 16) . In Abia central zone, there was no statistical relationship p=0.262 between type of school and refractive errors, but hyperopia was higher compared to myopia in both public and private schools. With respect to myopia though, it was found to be higher in public schools (Fig 17) . But in Abia South p= 0.021 and Abia South p= 0.000, there was a statistically significant relationship. In Abia South and north, myopia was more common across both school types, though higher in public schools (Fig 18 & 19).

The location of the schools whether it was in rural, semi-rural or urban areas affected the distribution of refractive error. In the whole state, there was a statistical significance between the location of school and refractive errors p= 4.97×10^{-39}. This effect thought weak using Cramers method v= 0.14 was still present (Fig 20) with myopia and hyperopia being almost the same. In different zones, in Abia Central, p=0.106 there was no statistical effect of location on refractive error. Hyperopia compared to myopia was more common across all the locations in Abia Central (Fig 21). Abia South p=0.001 showed there was a significant effect in refractive error which was more myopic across all the locations (Fig 22). Abia North p=0.000, had a similar result with Abia South with myopia being more prevalent across all schools locations (Fig 23). Li *et al.,* (2023) found that urban living increased myopia in China (Li *et al.,* 2023).

The time spent on studying affected refractive error p=1.17×10^{-8} with negligible Cramers effect v= 0.09 (Table 30). In Abia Central, majority had responded to yes to long study times, being the same with both those who were myopes and hyperopes, while those who responded no to the question, were more hyperopes (Fig 24). Myopes spent longer hours studying 5-12 hours, whereas hyperopes less hours, less than 5 hours studying (Fig 25). In Abia South p=0.271 showed no significant relationship between study time and refractive errors (Fig 26). In Abia North P=0.757 had a similar response to Abia South with myopes having more study time (Fig 27).

The time spent on homework was similar to school study time in Abia State p= 2.782×10^{-51}. Cramers effect v= 0.16 was weak. More myopes spent longer studying time compared to hyperopes (Fig 29). In Abia central p=0.524, which was not statistically significant (Fig 30), while Abia South and Abia North p= 0.00, which was statistically significant (Fig 31 & 32). Myopes consistently spent longer studying time.

The analysis on the time spent outside by the students showed a relationship between time spent outside and refractive errors P= 1.91×10^{-11} in Abia State, with cramers effect v= 0.11. There was no statistically significant effect across all the 3 zones with Abia Central p= 0.571, Abia South p=0.108 , Abia North p= 0.304 respectively (Fig 33-36). Xiong *et al.,* and Jonas *et al.,* (2021) in their review of myopia and its progression, highlighted the known importance of outdoor time and its reduction in especially myopia (Xiong *et al.,* 2017 and Jonas *et al.,* 2021).

The type of lighting available for study such as desklamp, room light, natural light and candle light statistically affected refractive errors P= 1.396×10^{-18} with cramers effect = 0.37 (Fig 37). In Abia Central p= 0.515 and Abia North 0.131 respectively, there was no statistical effect shown between the type of lighting available for study and refractive error (Fig 38 & 39). But Abia South p= 0.000 showed a statistical effect between lighting and refractive error (Fig 40). All the different types of lighting available was used equally across all the different refractive error groups except in Abia South where more myopes used more desk and room lights. Time spent outside in certain countries involved skylight. Xiong *et al.,* (2027) and Jonas *et al.,*

(2021) in their review of myopia and its progression, highlighted the known importance of outdoor time and its reduction in especially myopia (Xiong *et al.,* 2017 and Jonas *et al.,* 2021). Though in other countries especially in the temperate regions and north pole this may involve certain periods of reduced sunshine, compared to those who live in the tropics where there is sun all year round.

There was a significantly significant relationship between time spent on screen and refractive errors $p= 1.289 \times 10^{-87,}$ and cramers effect v=0.15. In Abia Central, yes and no response p= 0.514 (Fig 42), length of time p= 0.470 (Fig 43); showed no signifcant relationship between screen time and refractive error, hyperopes were more. In Abia South, p= 0.000 both to yes and length of study time showed there was a significant relationship between time and refractive errors, with myopes spending more time on screen >1 hour, compared to hyperope (Fig 44 & 45). The response and p value was similar for Abia North and South with more myopes spending more screen time (Fig 46 & 47). Foreman *et al.,* (2021) in his systemic analysis found that there was a relationship between screen time and myopia (Foreman *et al.*, 2021).

We tested for effect of parents occupation to refractiver error distribution and there was a statistical effect $p=1.51 \times 10^{-5}$ which was weak with cramers method v= 0.08 (Fig 48). This effect was lost in sub groups, With Abia Central p= 0.742, Abia North p= 0.859 (Fig 49 & 50) and only seen in Abia South p = 0.03 (Fig 51) where majority was mostly myopic compared to their other counterparts in other zones . Most of the participants, their parents had blue collar jobs, which involved being self employed, menial jobs etc in order to keep a home, and the refractive errors were spread out equally. Fernandes *et al.,* (2024) in Brazil studied on the impact of low income areas on refractive errors on school children, myopia was more prevalent in the adults while hyperopia in the younger population (Fernandes *et al.,* 2024).

V. Conclusion

In conclusion, this study has shown that many factors such as gender, level of education, study time both in school and home work, location of school whether in urban, rural, or semi rural, exposure to screen time, time spent outdoors, and the type of jobs done by parents can also affect the exposure and ability of parents to buy glasses for refractive error correction for their children. This has generated data in the region, showing those more prone to myopia and hyperopia and will help with sevices planning, enlightenment campaigns on outreaches to help the region.

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Credit authorship contribution statement

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