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ASSESSMENT OF NEAR EXOPHORIA AMONG STUDENTS OF FEDERAL POLYTECHNIC NEKEDE, OWERRI

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ABSTRACT
Near exophoria occurs when the position of the lines of sight either diverge at near or converge to a point further away than the near point. Large degrees of near exophoria ($\geq 6^{\Delta}$) contribute immensely to the visual problems affecting students. This study traced the distribution of near exophoria among students of Federal Polytechnic Nekede Owerri. 306 students (131 males and 175 females) aged between 16 to 27 years were selected randomly from the different faculties that make up the Institution. Their heterophoria states were ascertained and measured with the Maddox rod. The data collected were classified into three near phoria states: exophoria, esophoria and orthophoria. The data were analysed using frequencies, percentages and represented on bar charts. The study revealed that exophoria was the most prevalent (60.4%) phoria at near. It was found that near exophoria increased with increasing age among the students while statistical analysis revealed that there was no significant relationship between near exophoria and gender among the students. It was observed that, out of the 152 students who had large phoria measurements equal to or more than six prism dioptres (≥6 p.d), 111 (73%) of them were symptomatic. Only 30 (27%) out of these symptomatic students had corrective spectacles. It is therefore recommended that Government sponsors visual screening programmes of tertiary students to detect the cases of phoria and/or other vision problems that may have an impact on their academic performance and daily living, and as such treatment administered promptly.

KEYWORDS: Esophoria, Exophoria, Federal Polytechnic Nekede, Heterophoria, Maddox rod, Vision problem.

1. INTRODUCTION
Heterophoria refers to a state that both eyes have a tendency to deviate but can be compensated by the fusion to maintain alignment and binocular vision (Han, et al., 2020).[1] Heterophoria is mainly caused by the imbalance of binocular extraocular muscle force and the insufficient or unnecessary convergence required. Convergence is the ability to turn the eyes so that both focus in on the same object, at the same time, and at the same distance in space (Horn, 2011).[2] Underconvergence or Overconvergence can lead to an altered perception of the world. Underconvergence (which is also known as exophoria) is the tendency for the eyes to deviate outwards. Overconvergence (also known as esophoria) is the tendency for the eyes to deviate inwards. Both of these tendencies can affect how people learn, interact with others and understand their sorroundings (Horn, 2011).[2] Thus, Heterophoria can be classified into exophoria and esophoria with orthophoria (i.e no phoria) being a condition in which the visual axes of the two eyes remain parallel when all stimuli to fusion have been eliminated. Most people are orthophoric at distance or more nearly so. The near phoria in contrast to the distance phoria tends to vary considerably from one individual to another. The norm or expected value of the near phoria is about 3^{Δ} - 5^{Δ} of exophoria (physiological exophoria) (Grosvenor, 2002).[3]

A phoria may be caused by high uncorrected refractive errors, accommodative-vergence anomalies (i.e divergence excess and convergence insufficiency) and anatomical factors, as well as increased near-task demands (Grosvenor, 2007).[4] Patients with convergence insufficiency usually present as teenagers or early adulthood with gradually worsening symptoms of headache, asthenopia, blurred vision and infrequent diplopia during the near work (Sarwat, 2017).[5] These symptoms get worse by prolonged near work at the end of the day, illness, anxiety and insomnia. In the same vein, Grosvenor (2007)[4] also asserted that a phoria may become decompensated (manifest symptoms) when fusional vergence is inadequate to compensate for the demand. He further stated that the symptoms in decompensated phoria include headaches, photophobia

and eye strain and may affect visual efficiency and/or lowered academic performance in school children. Smaller degrees of near exophoria give rise to no symptoms, only when the deviation is great over 6^{Δ} is there usually marked distress (Duke Elder, 1993).[6] Large degrees of near exophoria (> 6^{Δ}) contribute immensely to the visual problems affecting students and Borish as shown in Grosvenor (2002)[3], acknowledged this condition as being associated more with myopes than hyperopes due to lack of accommodative convergence at near point common to myopes.

The incidence of near exophoria increases with additional near work demand, thus the disorder is rare in children younger than ten years, however this adversely affect academic achievement (especially in the upper grades) as near task demands increase (Wajuihian & Hansraj, 2016; Sarwat,2017).[7,5] Most times, to avoid these asthenopic complaints, patients desist from reading or engaging in other close work visual demands. Children with vision problems and other visual impairments struggle in school, straining to make out blurry images on the board, squinting to see classroom demonstrations and falling behind in everyday tasks and homework. Even leisure activities such as playing ball or watching movies present difficulties to the child and the child may be labeled as having learning or behaviour problem. Poor vision may even lead to a child dropping out of school as a result of chronically poor academic performance. Uncorrected binocular vision problem may not be life threatening but they can be "quality of life threatening" by negatively affecting academic achievement, social adjustment and economic survival (Kotingo et al., 2014).[8]

Hashemi et al.[9] in their study noted that the prevalence of near exophoria was 11.7% among university students in Iran. They also noted that there was a significant difference in the overall prevalence of exophoria according to the age. The prevalence of exophoria was also found to be significantly higher in myopic participants.[9] Wajuihian (2018)[10], in his study on the prevalence of heterophoria and its association with near fusional vergence ranges and refractive errors found out that the prevalence of exophoria at near was 51.3% among students aged 13 to 18 years. A study on heterophoria in children aged 6-13 years in Limpopo reported a mean of 2.5± 2.37 prism dioptre (pd) exophoria for horizontal phoria at near fixation (Wajuihian, 2018).[10] He also, in another prospective study, reported data for 139 clinic patients whose ages ranged between 20 and 36 years where the mean horizontal phoria at near was found to be 2.1 ± 6.2 pd exophoria. Makgaba (2006) as reported by Wajuihian (2018)[10], retrospectively analyzed record cards of 336 patients (aged from 18 t0 30 years) who were examined at the Optometry clinic of the university of Limpopo. The near horizontal phoria was 3.84 ± 4.80 pd exophoria. Akpe et al. (2014)[11] studied children aged between 5 and 19 years in Nigeria and found the prevalence of heterophoria was 23% at distance and 53.6% at near.

Vaishali et al. (2019)[12], in their study found out that the prevalence of convergence insufficiency(which is a known cause of near exophoria) among patients aged 18 to 35 years of age was found to be 27.46%. There is great variability in the reported prevalence of convergence insufficiency from 1.75% to 33% (Cooper and Jamal, 2012).[13] The prevalence of convergence insufficiency in school-age children documented in certain literatures ranges from 2% to 13% while the prevalence of convergence insufficiency in older age groups defined by those over the age of 19 was found to be approximately 1 in 6 (Ghadban et al., 2015).[14] Treatment may include eye exercises, prism (combination of treatment is most effective) or surgery in rare cases (Sarwat, 2017)[5]. Surgery is the last option in case of large exophoria. Pencil- push-up exercises are the most effective method for treatment of convergence insufficiency with exophoria (Jang et al., 2017).[15] This study aims to find the prevalence of near exophoria among students of Federal Polytechnic Nekede, Owerri.

2. MATERIALS AND METHODS

This was a cross-sectional study carried out on students of Federal polytechnic Nekede located in Owerri west Local Government Area (LGA), within a six (6) months period. Federal Polytechnic Nekede is a federal government owned higher institution located in Nekede, a town in Imo state, South-Eastern Nigeria. The institution offers National Diploma and Higher National Diploma course at undergraduate levels. It has 5 (five) schools (faculties) of study; School of Engineering Technology(SET), School of Industrial and Applied Science (SIAS), School of Business Management Technology (SBMT), School of Humanities and Social Science (SHSS) and School of Environmental Development Technology (SEDT).

Population of Study

This consisted of students (who are not blind in either of the eyes) of ND (National Diploma) and HND (Higher National Diploma) in the various schools/ faculties that make up the Federal polytechnic Nekede, Owerri.

Sample size determination

According to Younas (2019)[16], for sample size calculation of unknown population size, the following formula can be used: $n = z^2. [p*q]/d^2)$ where n is the sample size, P is the estimated proportion of the study variable or construct based on previous studies or pilot studies, q= 1-P, d is the margin of error and z= Z-score.

Thus, to calculate sample size n, for this study; our margin of error, d will be set at 5% and the Z-score for this will be 1.96. P will be 27.5% which is estimated based on a previous study by Vaishali et al. (2019)[12] on the prevalence of convergence insufficiency between 18 and 35 years and its relation to body mass index. The

prevalence of convergence insufficiency in their study was found to be 27.5%. Thus, in this study, q = 1- p = (1-0.275)= 0.725

Therefore,

$n = (1.96)^2 (0.275*0.725)/ (0.05)^2$

= 3.84 (0.199 /0.0025)

=3.84 (79.6)

=305.7

Therefore our sample size for this study can be approximated to 306

n= 306

Sampling method

Using a simple random sampling technique by balloting, two Schools(faculties) were selected out of the five schools listed above. The two schools selected were, School of Industrial and Applied sciences (SIAS) and School of Business Management Technology (SBMT). A list of the twenty nine (29) departments that make up the two schools (faculties) were made. Systematic random sampling technique was used to select every fourth department making a total of seven (7) departments. Students were randomly picked from these seven (7) departments irrespective of age, sex or class.

Method of data collection

After consent was obtained, the researcher with the aid of four other research assistants conveyed the selected students in private vehicles to the clinical laboratory of Dispensing Opticianry department in Federal Polytechnic Nekede where the necessary tests were carried out.

In order to obtain first-hand information and valid results, the researcher made use of questionnaires, oral and physical examination. In the course of the interview, the interviewer, with the aid of the student/subject, filled the necessary information in the questionnaire especially as regards their demographic data (age, name and sex) as well as condition of general health to ensure none was suffering from or undergoing treatment for any systemic diseases like malaria which could affect the eyes. They were also questioned for symptoms like asthenopic complaints, headaches and blurred vision, after which the interviewer, having obtained the student's consent, conducted the visual acuity (VA) test at distance and at near, as a routine part of all eye examinations (Hennelly, 2019)[17] using the Snellen acuity chart and near chart respectively.

External eye examination where the students were observed for the absence of abnormalities like tropia, ptosis and other ocular injuries were carried out as well as the phoria test which was conducted using the Maddox rod technique. In this procedure, a dim illumination was required. The red Maddox rod was placed with its horizontal axis in front of the subject's right eye. The subject was asked to report the relative position of the Maddox rod streak with respect to the white light, which was shown at a distance of 40 cm. The distance between the Maddox rod streak and the torchlight was neutralized with the help of prisms and the values recorded to the nearest one prism dioptre.

Institutional based review approval was obtained for this study.

Data analysis

Data obtained were represented with frequencies and bar charts while tests for statistical significance were done by Chi-square analysis.

3. RESULTS

Three hundred and six (306) students were selected and examined. There were 131(42.81%) males and 175(57.19%) females. The age range was from 16 to 27 years, mean age (19.02) and standard deviation of (±1.72). It was found that 185 (60.4%) of the students were exophoric at near, followed by esophoria 84 (27.5%) and then orthophoria 37 (12.1%). This study revealed that near exophoria increased with increasing age among students of Federal Polytechnic Nekede, Owerri and statistical analysis revealed that there was no significant relationship between exophoria at near and gender among students of Federal polytechnic Nekede, Owerri. It was observed that, out of the 152 students who had large phoria measurements equal to or more than six prism dioptres (≥6 p.d), 111 (73%) of them were symptomatic. 30 (27%) out of these symptomatic students had corrective spectacles. A vast majority of the subjects were exophoric at near in this study.

TABLES

Table 1: Distribution of near heterophoria among students of Federal Polytechnic Nekede, Owerri.

Near heterophoria	Frequency	Percentage (%)
Exophoria	185	60.4
Esophoria	84	27.5
Orthophoria	37	12.1
Total	306	100.0

Table 2: Sex distribution of respondents/students of Federal Polytechnic Nekede, Owerri.

Sex	Frequency	Percentage (%)
Male	131	42.81
Female	175	57.19
Total	306	100. 00

Table 3: Sex distribution of near heterophoria among students of Federal Polytechnic Nekede, Owerri.

Sex	Near exophoria	Near esophoria	Orthophoria	Total
Males	71	36	24	131
Females	114	48	13	175
Total	185	84	37	306

Table 4: Sex distribution of Near exophoria among students of Federal Polytechnic Nekede, Owerri.

SEX	Exophoric At Near	Non-Exophoric At Near	Total
Males	71 (54.2%)	60	131
Females	114 (65.1%)	61	175
Total	185	121	306

Table 5: Age distribution of respondents and mean near exophoria of the different age groups.

Age (years)	Frequency	Mean near exophoria SD
16-18	102	4.9 exo ± 1.4
19-21	105	5.7 exo ± 1.4
22-24	76	6.6 exo ±1.4
25-27	23	6.9 exo ±1.1
Total	306	

Table 6: Age distribution of students with large exophoric values (≥6 p.d) who were symptomatic.

Age (years)	Frequency of students with near exophoria of ≥6 p.d)	Frequency of students who complained of experiencing at least three symptoms during near task
16-18	33	21
19-21	38	26
22-24	65	52
25-27	16	12
Total	152	111

Table 7: Frequency distribution of symptomatic students who had corrective spectacles.

Age (years)	Frequency of students who complained of experiencing at least three symptoms during near task	Frequency of students who had corrective lenses
16-18	21	3
19-21	26	7
22-24	52	12
25-27	12	8
Total	111	30 (27%)

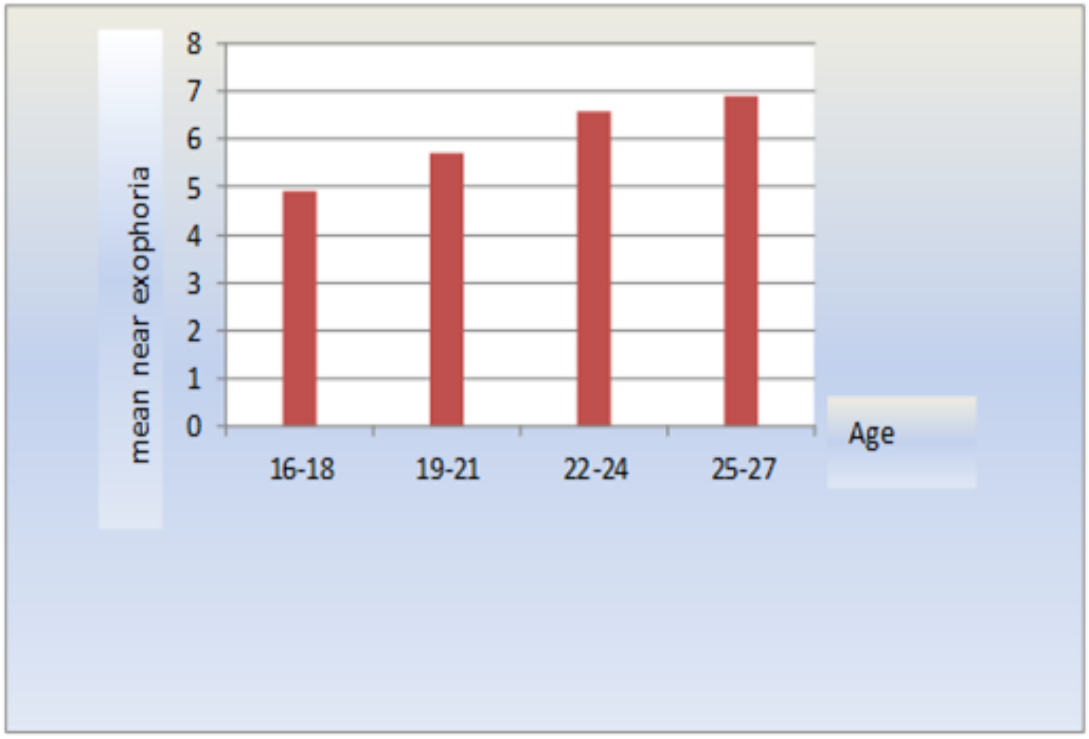

Fig. 1: Showing the mean near exophoria of the different age groups.

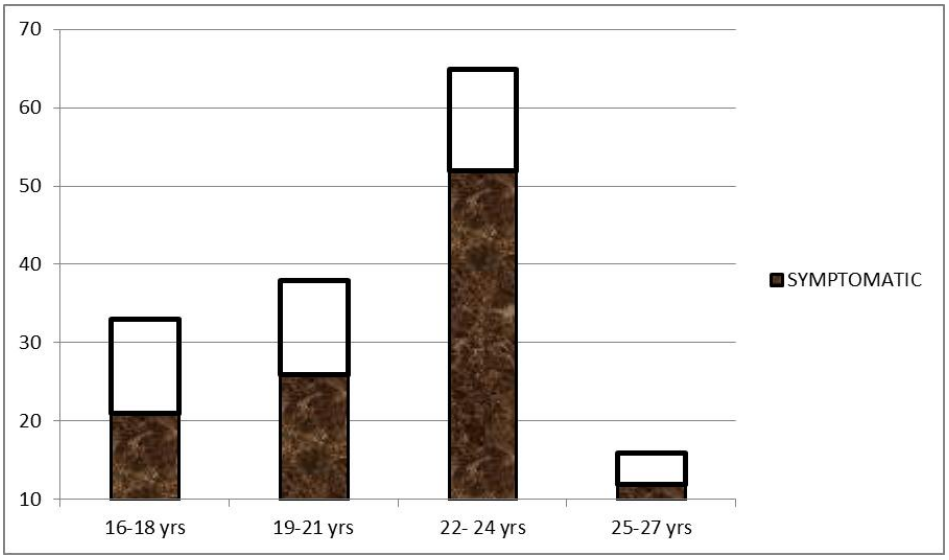

Fig 2: Showing Age distribution of students with large exophoric values (≥6 p.d) showing those who were symptomatic.

Testing The Hypotheses Proposed In The Study

Null Hypothesis: There is no significant gender difference in the prevalence of near exophoria among students of Federal Polytechnic Nekede.

TABLE 8: ***Chi Square Test Of The Prevalence Of Near Exophoria Among Males And Females In Federal Polytechnic Nekede.***

Firstly, A 2X3 Contingency table illustrating Sex and presence of near exophoria among students of Federal Polytechnic Nekede, Owerri.

SEX	EXOPHORIC AT NEAR	NON-EXOPHORIC AT NEAR	TOTAL
Males	71	60	131
Females	114	61	175
Total	185	121	306

Because the contingency table above has two rows and two columns, the number of degrees of freedom is $(r - 1)(c - 1)$.

Where r is the number of rows and c, number of columns

i.e $(2 - 1)(2 - 1) = (1)(1) = 1$ degree of freedom

$$\chi^2 = \Sigma \frac{(Fo-Fe)^2}{Fe}$$

Fo= Observed frequencies

Fe= Expected frequencies

RT= Row total for the row containing that cell

CT= Column total for the column containing that cell

N = Total number of observations

Fo	Fe= RTXCT / N	(Fo-Fe)²/Fe
71	131 x 185 / 306 = 79.2	0.85
114	175 X 185 / 306 = 105.8	0.64
60	131 X 121 / 306 = 51.8	1.30
61	175 X 121 / 306 = 69.2	0.97
	χ^2cal	**3.76**

χ^2cal of 3.76 is less than χ^2tab of 3.84 at 95% confidence interval, one (1) degree of freedom thus we accept the null hypothesis that there is no significant relationship between exophoria at near and gender among students of Federal Polytechnic Nekede, Owerri.

4. DISCUSSION

Table 1 shows that the prevalence of near exophoria in this study was recorded as 60.4%. This is similar to the report recorded by Wajuihian (2018)[10] who found the prevalence of near exophoria to be 51.3% among students aged 13-18 in South Africa. The slight difference in the percentages could be as a result of the difference in study areas as well as the slight age difference between the study populations of the two studies. The higher percentage recorded in this study is speculated to be due to the fact that the population is made up of tertiary students, who are presumably exposed to increased visual demands of school work and digital screen time (like the use of mobile phones, laptop computers) which often time results to accommodative fatigue.

The speculation above is in line with the study by Eunjung (2016)[18] who stated that adults younger than

30 were most vulnerable to eye strain resulting from the use of digital devices. However, the notable prevalence (60.4%) of near exophoria observed in this study differs from that of Hashemi et al (2019)[9] who noted the prevalence of near exophoria among university students in Iran to be 11.7%. this disparity could be due to the racial difference between the Iranian and Nigerian population.

Tables 2 and 3 show the sex distribution of near exophoria among the participants and Table 4 revealed that near exophoria affected females (65.1%) more than males (54.2%). This is similar to the results recorded by Sarwat (2017)[5] in her study on the frequency of exophoria among the convergence insufficiency patients, where the occurrence of near exophoria was found to be 57.8% in females and 42.2% in males.

Table 5 and Fig.1 revealed that near exophoria increased with increasing age. This is in line with the assertions by Hrynchak (2011)[19] and Ghadban et al. (2015)[14] who reported in their different studies that age is associated with an increase in the prevalence of exophoria at near. However, Makgaba (2006)[21] in his analysis of heterophoria values in a population of students aged 18-30 years in South Africa found no correlation between heterophoria and age. This differs from the findings of this study probably due to the difference in the years the studies were carried out. This is because as at 2006 when the study by Makgaba was carried out, the use of digital devices (which probably contributes to the notable prevalence of near exophoria recorded in most studies) has not become as common as it is today.

Table 6 revealed that there is no significant relationship between exophoria at near and gender among students of Federal Polytechnic Nekede, Owerri. This is similar to the findings by Nusz et al (2005)[22] who stated in their study that intermittent exotropia was nearly twice as common in girls compared with boys in the defined population but there were no significant historical or clinical differences between the genders. In the same vein, Chaudhry et al (2009)[23] in their study on gender differences and delay in presentation of childhood squint, reported that girls also had a higher burden of amblyopia compared with their male counterparts though the difference was not statistically significant (P = 0.09). However, Makgaba (2006)[21] found a statistically significant gender variation in the near horizontal heterophoria values ($p > 0.05$).

It was observed in Table 6 that, out of the 152 students who had large phoria measurements equal to or more than six prism dioptres (≥6 p.d), 111 (73%) of them were symptomatic. It was also observed in Table 6 that large degrees of exophoria (≥6 p.d) were recorded more among the older students. This is in accordance with some studies where it was stated that the incidence of near exophoria increases with additional near work demand, thus the disorder is rare in children younger than ten years, however this adversely affect academic achievement (especially in the upper grades) as near task demands increase (Wajuihian & Hansraj, 2016; Sarwat,2017).[7,5]

Table 7 showed that, in this study, 30 (27%) respondents out of the 111 symptomatic students in Federal Polytechnic Nekede, Owerri had corrective spectacles. The poor record of symptomatic students who had corrective lenses as observed in this study may be as a result of so many reasons including unawareness of the need to obtain corrective lenses, unaffordability of eye care services, unawareness of eye care centre domiciled in the institution etc..

5. CONCLUSION

This paper shows the high Assessment of near exophoria among students of Federal Polytechnic Nekede. High degrees of near exophoria especially when accompanied by an inadequate fusional vergence will cause asthenopic symptoms for the patient. These asthenopic symptoms evident in a decompensated phoria include headaches, photophobia and eye strain and may affect visual efficiency and/or lowered academic performance in students. Most of the students that had these symptoms were not aware of their problems and some of those who knew could not afford its treatment.

The findings of this study is a call to action to ensure tertiary students undergo screening programs to detect the cases of phoria and the mainstays of treatment of especially high degrees of near exophoria (i.e orthoptics and/or base-in prisms) administered early enough. Again, refractive errors when present can be detected early and corrected. Government should endeavour to sponsor visual screening programmes for its subjects as binocular dysfunctions are significant health problems in Nigeria that may have an impact on visual function and daily living.

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