Determination of Interpupillary Distances Among Students of Igbo Origin in Madonna University, Elele, Rivers State, Port Harcourt, Nigeria.

[1]**Amadi PN,** [1]**Peters EC,** [2]**Fawehinmi HB,** [3]**Ilochi ON,** [2]**Oladipo GS,** [4]**Ewunonu EO,** [4]**Umahi-Otta G,** [1]**Osaat RS,** [5]**Obi KC**
[1]Department of Human Anatomy, Madonna University Nigeria
[2]Department of Anatomy, University of Port Harcourt, Nigeria
[3]Department of physiology, Madonna University, Nigeria
[4]Department of Anatomy, Ebonyi state University, Nigeria
[5]Department of Anatomy, University of Abuja, Nigeria

ABSTRACT
Pupillary distance (PD) or inter-pupillary distance (IPD) is the distance measured in millimeters between the centers of the pupils of the eyes. The present study evaluates the inter-pupillary distances amongst Madonna University undergraduates of Igbo origin. The sample size comprised of 125 Igbo males and 125 Igbo females which comprised only of young adults (18-25years). The modified Viktorin's method was used in the study. Measurements of inter-pupillary distances were taken by the use of a millimeter inter-pupillary distance ruler. This can be observed from figures 1, 2, 3, 4 and 5. The male mean value 36.53 was significantly higher than the female value 32:65 for the FIPD (far inter-pupillary distances). The difference between the NIDP (near inter-pupillary distances) and FIDP (Far inter-pupillary distances) was statistically significant in all particular age groups of either sex. The overall anatomical far inter-pupillary distance (FIPD) for the males was, on the average, wider than the near inter-pupillary distance (NIPD), with a difference of 6.7 mm in males and 5.6 mm in females. This study has established that there is a significant difference between the inter-pupillary distances among the Igbo male and female students of Madonna University, Elele campus, Rivers state, Nigeria.

Keywords: Far inter-pupillary distance, near inter-pupillary distance, sexual dimorphism

INTRODUCTION
Pupillary distance (PD) or inter-pupillary distance (IPD) is the distance measured in millimeters between the centers of the pupils of the eyes [2]. Optometrists are often the first health care practitioners to diagnose patients with accommodative or vergence dysfunction [4].

The eye is an organ that detects light and sends signals along the optic nerve to the brain. In humans, the eye is a valuable sense organ that gives us the ability to see. It allows for light perception and vision, including the ability to differentiate between colors and depth.

The clinical importance of IPD is to facilitate the correct positioning of ophthalmic lenses before the eyes to eliminate unwanted strain on the eyes due to induced prismatic effects from the lenses.
The factors Influencing IPD are gender, race, and age. Mean IPD Inter Pupillary Distances is important in the design of stereoscopic display devices and the production of stereoscopic content [9].

Figure 1: Measure of pupillary distance

Pupillary distance is an important measurement used to determine the proper lens shape and alignment of your prescription correction to your line of vision. Without an accurate PD Pupillary Distance measurement, correcting vision can be difficult since lenses need to be aligned over the center of your pupil for proper clarity.

Generally, adults have a PD Pupillary Distance within the range of 54-68 mm, while children have a PD Pupillary Distance within the range of 41-55 mm. Pupil distance can be measured in two ways. The first is called binocular, which is a pupil-to-pupil measurement, this type of measurement will be between 41-80 mm. The other type of measurement is called monocular, which is a per-eye measurement from the pupil to the middle of the face, this type of measurement will be between 20-40 mm. Monocular measurements are most often used when the face is not perfectly symmetrical, meaning one eye is closer or farther from the middle of the face than the other.

MATERIALS AND METHODS
This study included 125 males and 125 females within the age range of eighteen (18) to twenty five (25) years of age of the Igbo ethnic group in Madonna University, Elele, Rivers state, Nigeria.
The Inter-pupillary distances are sometimes difficult to measure therefore a simple alternative method known as the modified Viktorin's method was employed. This method was used in the present study because it was primarily designed to observe the anthropometric variation pattern of the parameter. We measured the distance between the nasal and lateral limbus of subjects with a millimeter ruler.

Each subject was seated comfortably in a chair. The subject's head was at the same level as, and 40 cm in front of, the examiner's head. The subject's face was well illuminated, and the ruler was held firmly against the subject's nose.

The Researcher first closed his right eye and asked the subject to look at his opened left eye. The zero mark on the ruler was placed at the outer limbus margin of the subject's right eye while the examiner sighted with his opened left eye the point of the ruler that corresponded to the inner limbus of the subject's left eye.

This measurement is equivalent to the near inter-pupillary distance. The examiner then closed his left eye and asked the subject to look at the researcher's opened right eye. While still maintaining the zero mark on the ruler at the outer limbus of the subject's right eye, the examiner sighted the point on the ruler that corresponded to the inner limbus of the subject's left eye. This measurement is equivalent to far inter-pupillary distance.

Figure 2: Measuring a male participant for far inter-pupillary distances.

Distance Inter Pupillary Distance:
- The subject was comfortably seated such that his/her eyes were at the same level as the researcher's and the pupillometer rule was gently placed over the subject's eyes.
- With the researcher and participant appropriately positioned, the researcher closed his right eye and the subject was instructed to fixate on the research's opened left eye.
- The temporal limbal margin was chosen as a point of reference on the patient's right eye. The zero point on the ruler was aligned with this reference point. The examiner then closed his left eye and opened his right eye and the subject was instructed to fixate on the examiner's open right eye.

[1]Amadi PN, [1]Peters EC, [2]Fawehinmi HB, [3]Ilochi ON, [2]Oladipo GS, [4]Ewunonu EO, [4]Umahi-Otta G, [1]Osaat RS, [5]Obi KC

- The nasal limbal margin was chosen as a point of reference on the patient's left eye. Without any movement of the pupillary distance meter rule, the point on the rule coinciding with the appropriate reference point on the patient's left eye was noted.
- The distance PD reading was obtained as the distance from the zero point on the rule to the point on the rule that coincided with the reference point in the patient's left eye. This was recorded in millimeters (mm). This procedure was repeated three times on each subject and the average reading recorded as the subject's distance PD.

Near inter pupillary distance:

- The subject was instructed to fixate on the examiner's nose bridge. The zero mark on the ruler was aligned with the temporal limbal margin of the subject's right eye whilst noting the mark on the ruler that coincided with the nasal limbal margin of the subject's left eye.

- The distance between the inner and outer limbi of the right and the left eyes respectively was recorded in millimeters (mm). This procedure was repeated three times on each subject and the average reading recorded as the subject's near PD.

Figure 3. The Inter-pupillary distances meter rule.

Inclusion Criteria: Students included in the study were apparently healthy, without any abnormal cranio-facial configuration and without any manifestations of ocular deviations. Students that did not have a deformed face. Students that did not have a deformed nose bridge. Students that did not have eyes deformities. Students that are from a full Igbo origin and Igbo descent. Students that had no physically deformed fingers.

Exclusion Criteria: Students excluded in the study were unhealthy, and also students with abnormal craniofacial configuration and those who manifested ocular deviations, students that had a deformed face, deformed nose bridge and eyes deformities; students that are not from a full Igbo origin and Igbo descent and those physically deformed fingers.

Limitations: This study is limited to only male and female students of Igbo origin in Madonna University. The age range considered in this work was between 18-25 years. Financial support was inadequate. Time was the most limiting factor due to examinations and school activities.

RESULTS
The following parameters were used during the research of getting the inter-pupillary distances among students of Madonna University that are of an Igbo origin in Madonna University, Elele, River State, Port Harcourt, Nigeria.
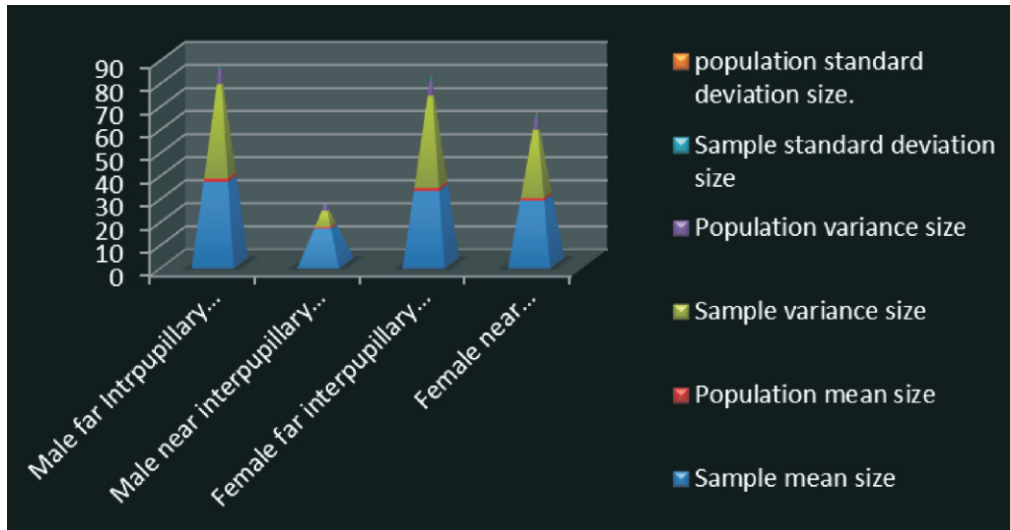
Figure 4: Graph of male and female inter-pupillary distance, population and sample size.

Table1: Interpupillary Distances Differences between Males and Females in Madonna University.

INTERPUPILLARY DISTANCE DIFFERENCES BETWEEN MALES AND FEMALES IGBO STUDENTS	MEAN.	MEDIA.	MODE.	VARIANCE.	STANDARD DEVIATION.
FAR INTERPUPILLARY DISTANCES BETWEEN MALE AND FEMALE IGBO STUDENTS.	8.70	12.30	10.30	3.50	1.80
NEAR INTERPUPILLARY DISTANCES BETWEEN MALE AND FEMALE IGBO STUDENTS.	25.20	6.22	69.10	43.6	21.80

From the graph below, it was observed that the Igbo male students had a significantly higher inter-pupillary distance in comparison to the female Igbo students in Madonna University.
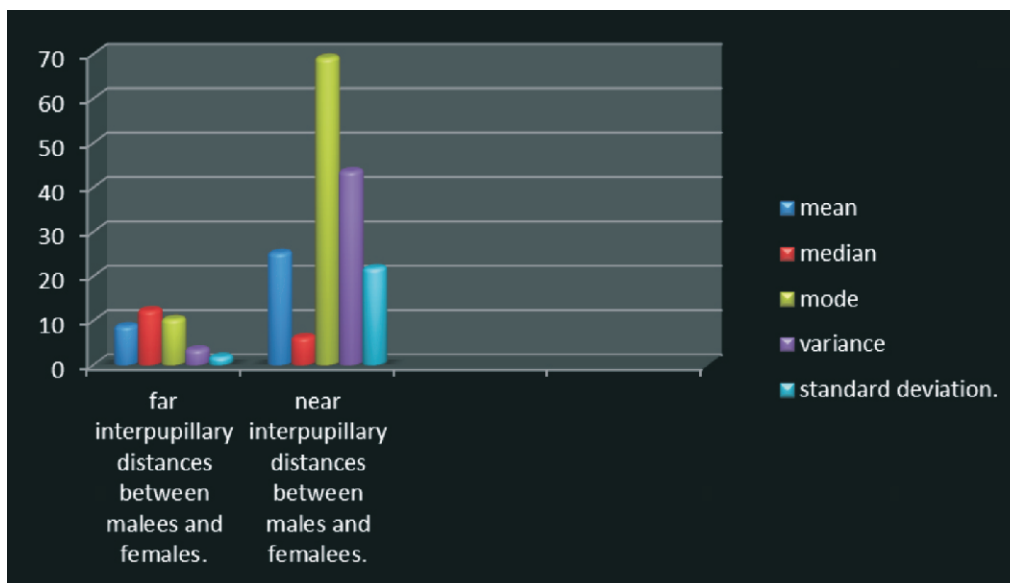

Figure 5: Diagram showing the differences of far and near inter-pupillary distances between Igbo male and female students.

[1]Amadi PN, [1]Peters EC, [2]Fawehinmi HB, [3]Ilochi ON, [2]Oladipo GS, [4]Ewunonu EO, [4]Umahi-Otta G, [1] Osaat RS, [5]Obi KC

Table 2: Estimated sample and population sizes of the Igbo male and female Igbo students of Madonna University.

INTEERPUPILLARY DISTANCES.	SAMPLE MEAN SIZE.	POPULATION MEAN SIZE.	SAMPLE VARIANCE SIZE.	POPULATION VARIANCE SIZE.	SAMPLE STANDARD DEVIATION SIZE.	POPULATION STANDARD DEVIATION SIZE.
MALE FAR INTERPUPILLARY DISTANCES.	36.53	1.52	39.9	6.32	1.67	1.29
MALE NEAR INTERPUPILLARY DISTANCES.	15.81	0.66	6.48	2.54	0.27	0.51
FEMALE FAR INTERPUPILLARY DISTANCES.	32.65	1.36	38.84	6.23	1.62	1.27
FEMALE NEAR INTERPUPILLARY DISTANCES	28.33	1.18	28.52	5.34	1.19	1.09

Table 3: Mean, median and mode of far and near inter-pupillary distances of males and females Igbo students in Madonna University, Elele, Rivers state, Nigeria.

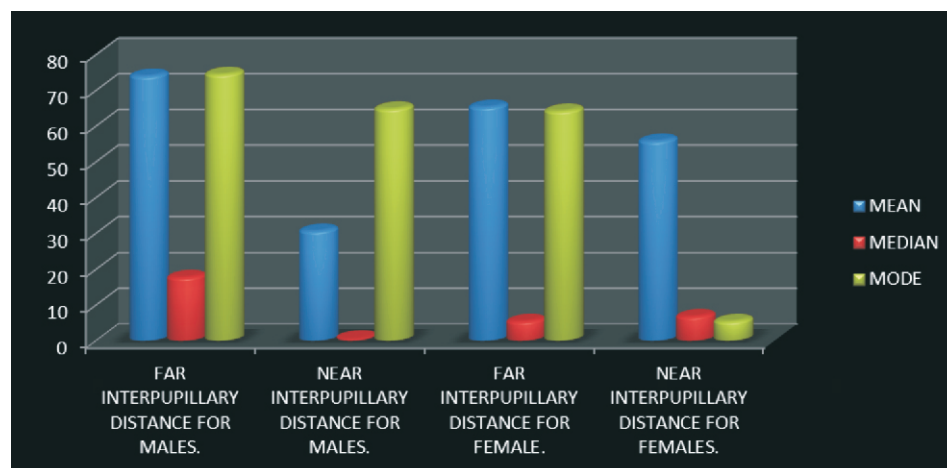| Inter-pupillary distances (in millimeters), in Madonna university, elele, river state, Nigeria.	Mean.	Median.	Mode.
Far inter -pupillary distances for Igbo male students.	74	17.7	74.5
Near inter -pupillary distances for Igbo male students.	30.6	0.53	64.82
Far inter -pupillary distances for Igbo female students.	65.3	5.4	64.2
Near inter-pupillary distances for Igbo female students .	55.8	6.75	5.4

Figure 6: Bar chart showing Mean, Median and Mode of far and near inter-pupillary distances of males and females Igbo students in Madonna University.

Table 4: Variance and standard deviation of far and near inter-pupillary distance of male and female Igbo students in Madonna University.

Inter-pupillary distances (in millimeters),in Madonna university, elele, Rivers state, Nigeria.	VARIANCE.	STANDARD DEVIATION.	
Far inter-pupillary distances for Igbo male students.	81.2	40.6	
Near inter-pupillary distances for Igbo male students.	12.6	6.3	
Far inter-pupillary distances for Igbo female students.	77.7	38.8	
Near inter-pupillary distances for Igbo female students .	56.2	28.1	
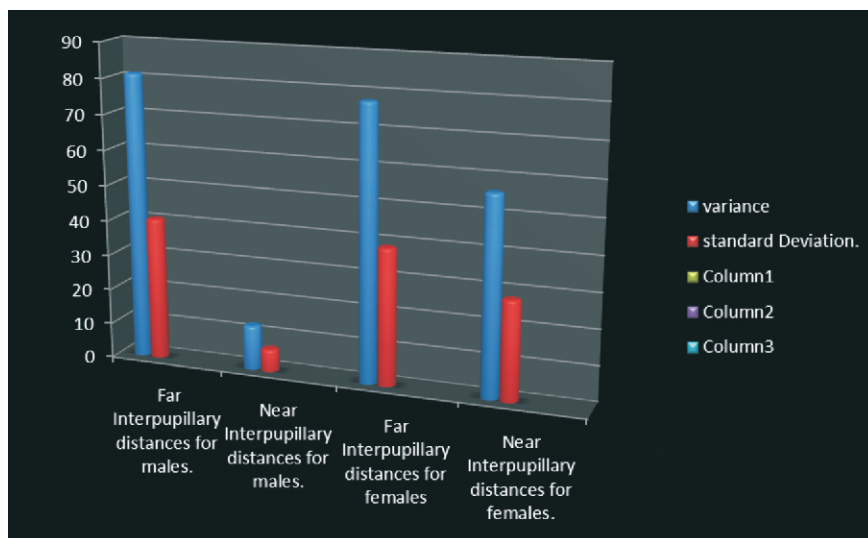
Figure 7: Bar chart showing the variance, standard Deviation of male and female Igbo student's inter-pupillary distances.

Table 5: Correlation between far inter-pupillary distances and the distances between the hand's (index and middle) fingers male and female Igbo students of Madonna University.

Sex.	Mean deviation.	Arithmetic Mean.	Variance.	Standard Deviation.	Coefficients of variance.(=standard deviation/arithmetic mean	Coefficient of mean deviation. = mean deviation/arith metic mean.
Male far inter-pupillary distances.	67.5	68.46	0.64	0.80	1.16	0.98
Male hand (index and middle)finger distance.	67.5	44.54	0.64	0.80	1.79	1.51
FEMALE INTERPUPILLARY DISTANCES .	65.75	68.99	69.33	8.32	12.0	0.95
FEMALE HAND(INDEX AND MIDDLE)FINGER DISTANCES .	65.5	64.99	68.78	8.29	12.75	1.00

[1]Amadi PN, [1]Peters EC, [2]Fawehinmi HB, [3]Ilochi ON, [2]Oladipo GS, [4]Ewunonu EO, [4]Umahi-Otta G, [1] Osaat RS, [5]Obi KC
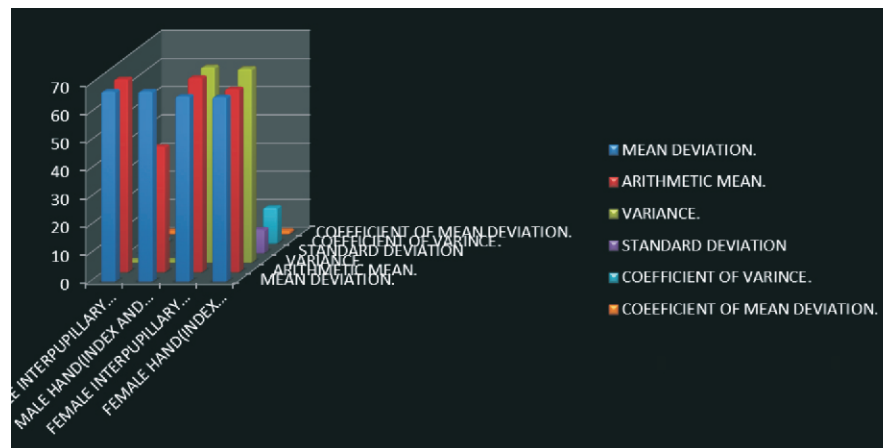
Figure 8: Correlation between of far inter-pupillary distances and distances between index and middle fingers of male and female Igbo students of Madonna University.

Table 6: Age of sex, mean deviation, Arithmetic mean, variance, standard deviation, coefficients of variance, coefficients of mean of males and females ages

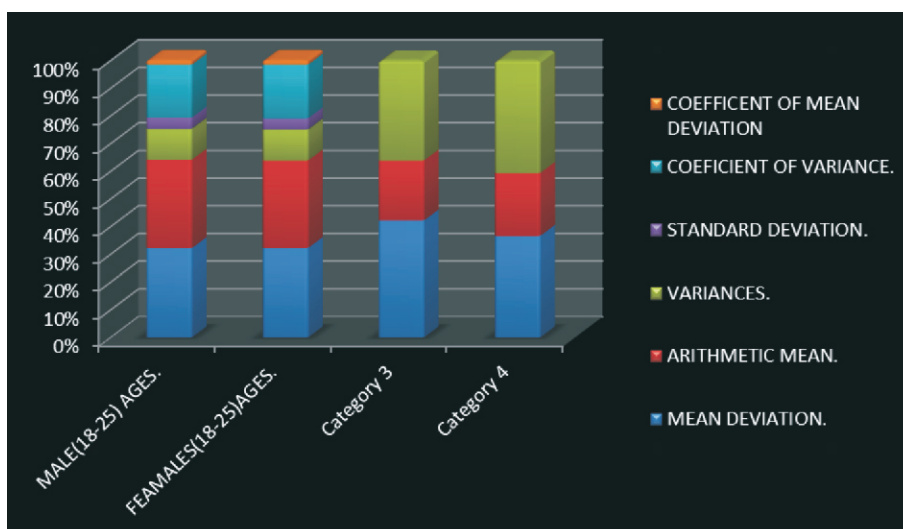| AGES OF SEX.	MEAN DEVIATION.	ARITHMETIC MEAN.	VARIANCE.	STANDARD DEVIATION.	COEFFICEINT OF VARIANCE.(=STANDARD DEVIATION/ARITH MEAN	COEFFICIENT OF MEAN DEVIATION.=mean deviation/arithmetic mean.
MALES (18-25)	21.50	21.35	1.46	2.73	12.78	1.00
FEMALES (18-25)	21.50	21.10	7.46	2.73	12.93	1.01

Figure 9: Graph of ages of male and female Igbo students.

DISCUSSION

In the research conducted in Madonna university among Igbo male and female students, the Igbo male students had a significantly greater far (distant) Inter-pupillary distance in comparison to the Igbo female students, the males had a mean value of 74 and the females had a mean value of 65.3, for the mode value of Igbo males to females, a value of 74.5:65.2 was recorded.

The males also had a record of median value of 17.7 to females which was 5.4.However,females had a significantly higher value in comparison to the males of Madonna University, the mean value for females was

55.8 to males which was 30.6, but the modal values for males was 64.8 to females 5.4 , the males had a record of higher modal value than the females, the median value for females was 6.75 to males which was 0.53.For the variance and standard deviation values in the far inter-pupillary distances, the measurement for the males still recorded higher values in comparison to the females in Madonna university, they had a recorded variance value of 81.2 to females 56.2 and a standard deviation value of males 40.6 to females 38.8.

Furthermore, the Near Inter-pupillary distances of the females had higher recorded variance and standard deviation values in comparison to males , the record values of female in the variance value was 56.2 to males 12.6 while for the recorded values of female in the standard deviation value was 28.1 to 6.3 for males.

Actually, the male and female Igbo students in far inter-pupillary distances recorded a mean difference of 8.7,for the media difference it was 12.30 ,for the mode difference it was 10.30,for the variance difference it was 3.50,and for the standard deviation difference it was 1.80.For the near inter-pupillary distances a mean difference between males and females it was 25.20, for the median difference it was 6.22, for the mode difference it was 69.10, for the variance difference it was 43.6 and for the standard deviation it was 21.80.

However, in estimating sample mean size and the population size, in far inter-pupillary distances, the males and females recorded a sample mean size of 36.53:32:65, for the sample variance size was 39.96:38:84, while for the standard deviation it was 6.32:5.34, for the population mean size it was 1.52:1.36, for the population variances size it was 1.67:1.62, for the population standard deviation size it was 1.29:1.27,

In near inter-pupillary distances, the males and females recorded a sample mean size of 15.81:28.33,for the sample variance size it was 6.48:28.52,for the sample standard deviation size it was 2.54:5.34,for the population mean size it was 0.66:1.18,for the population variance size it was 0.27:1.19,for the population standard deviation size it was 0.51:1.09.

Age and physical stature played a significant role in determining the large significant differences between Igbo males and Igbo females, those whose ages were between 18 eighteen and 20 twenty five had lesser values compared to those whose ages were above twenty 20 to 25 twenty five years of age.

Therefore, sexual dimorphism was observed in these researches of the inter-pupillary distances which had a significant difference among the male and female Igbo students of the Igbo ethnic group in Madonna University, Rivers state, Port Harcourt, Nigeria.

This research agrees with the study of the overall FIPD (far inter-pupillary distances) obtained in the present study in males being 7.4cm and in females 7.10cm. These values are higher than the reported values by [3] for the Tusks which they revealed to be 60.75mm for male and 59.45 mm female.

A survey of healthy Congolese children n conducted by [6] gave a mean of 69.2 mm and standard deviation of 3.9 mm for the oldest age group (11 children aged 15–18 years), these values are also higher than the reported values for the Igbos although if the standard deviation values are taken into consideration the values for the Igbos could as well fall within the range of the Congolese inter-pupillary distance. All these are evidences that different racial groups have different mean inter-pupillary distance. It can also be deduced from the literature that the values for the African race is higher than those of the Caucasians.

[1] reported that vast majority of adults lie within the range 50 to 75 mm. [7] also reported that the IPD of adult white males from the United States of America has a mean IPD which lie between 65 and 66 mm and that 90% of his subjects has an IPD between 60 and 70 mm, while 99.8% between 55 and 75 mm. However, the Igbo values which are higher than the reported values in the literature still fall within the range reported by [7] and [1].

As reported in previous studies, there is also a statistically significant difference between mean FIPD of male and female subjects in this study in the various age groups which also agrees with findings of [8]. [5] reported that mean IPD differed significantly between the two genders in certain age groups, this could explain the significant higher value noted in the young female (16-25 years old) compared to their male counterpart in the present study.

The study has shown that sexual dimorphism was found to be statistically significant ($p<0.05$) in all the measured parameters. The value of horizontal palpebral aperture (HPA) for northern Cross River irrespective of age groups (10-19) years indicates 3.58+_27cm in males and 3.51+_17cm females.

The present study also indicates that the overall inter-pupillary distances for the Northern Cross river ethnic population obtained in males and female subjects are 6.54+_18cm and 6.47+_25cm respectively for NIPD, and 6.69+_37cm and 6.59+_24cm respectively for FIPD.

CONCLUSION
This study has established that there is a significant difference between the inter-pupillary distances among the Igbo male and female students of an Igbo ethnic group as with the case with many tribes, as well as a significant correlative value between their hand's

[1]Amadi PN, [1]Peters EC, [2]Fawehinmi HB, [3]Ilochi ON, [2]Oladipo GS, [4]Ewunonu EO, [4]Umahi-Otta G, [1] Osaat RS, [5]Obi KC

(index and middle) finger distances and their far inter-pupillary distances. This is useful information for commercial frame and lens design and in clinical consideration when designing binocular optical instruments. Because of its immense benefits it is recommended that this type of study be carried out on other ethnic groups and races.

Our study results showed that gender and age had a significant effect on inter-pupillary distance.
The results of this study will be of immense use to the maxillofacial and plastic surgeons and in surgical procedures like ocular prosthetics, blepharoplasty and in forensic science to traces missing individuals by applying facial reconstruction techniques, dentistry, genetics and paleoanthropological studies.

RECOMMENDATION

I thereby recommend that further studies should be carried out to estimate, the degree or extent of the inter pupillary distances between the people of the Igbo race as well as other races in Nigeria in order to understand the physical and anatomical factors that determine its significance in our anatomical world.

The present studies suggested that the patient should be checked by skillfull optometrist for proper evaluation of interpupillary distance and make it an integral part of an eye examination. It is recommended that future study should include age below 15 years that is developmental age and inter-pupillary distance should be evaluated as it increases with advancing age as it will be beneficial to their study and treatment procedures.

CONTRIBUTION TO STUDY

The study carried out showed sexual dimorphism among students of Madonna University which were of an Igbo origin.
The studies carried out showed distance of the hand's (index and middle) finger represent the far inter-pupillary distances.

The Increased ages of students contributed to the increased far inter pupillary distances and near inter-pupillary distances male and female Igbo students while decreased ages of students contributed to the decreased far inter-pupillary distances and near inter-pupillary distances male and female Igbo students.

REFERENCES

1. Dodgson, NA. Variation and extrema of human interpupillary distance, In Proc. SPIE Stereoscopic Displays and Virtual Reality XI. A J Woods, J O Merritt, S A Benton, and M J Bolas (eds). San Jose Califonia, USA. 2004: 5291: 36-46.
2. Brooks, A., Brahnam, S., & JAIN, L. Technologies of inclusive well-being at the intersection of serious games, alternative realities, and play therapy. In A. L. Brooks, S. B. Brahnam, & L. C. Jain (Eds.), 2014*Technologies of Inclusive Well-Being* (1 ed., Vol. 536, pp. 1-10). Heidelberg: Springer. Studies in Computational Intelligence https://doi.org/10.1007/978-3-642-45432-5_1
3. Evereklioglu C, Doganay S, Er H, Gunduz A, Tercan M, Balat A. Craniofacial Anthropometry in a Turkish Population. Cleft Palate- Cleft Palate Craniofac J; 2002 39(2): 208–18.
4. Cooper, J. S., Raguse, B., Chow, E., Hubble, L., Müller, K. H., & Wieczorek, L. Gold nano particle chemiresistor sensor array that differentiates between hydrocarbon fuels dissolved in artificial seawater. *Analytical chemistry*, 2010 *82*(9), 3788-3795.
5. Gupta VP, Sdhi PK, Pandey RM. Normal values for inner intercanthal, interpupillary, and outer intercanthal distances in the Indian population. Int. J. Clin. Pract; 2003 57:25-29.
6. Kaimbo, D; Kaimbo, Wa; Ngiyulu MR; Tshilolo ML; Missotten, L. Outer orbital distance, inner canthal distance and interpupillary distance, proptosis in children with homozygous sickle cell disease", Bulletin of the Belgian Society of Ophthalmology, 2000 275:33–37, www.bog-sbo.org/bulletin/275_04.pdf
7. Hofstetter, H.w. Normal values of I terpupillary distances.J.Am Optometric Anthropometry for chilcrens spectacles frames . 1972
8. Maclachlan C, Howland HC. Normal values and standard deviation for pupil diameter and interpupillary distance in subjects aged 1 month to 19 years. Ophthalmic Physiol Opt; 2002 22:175-182.
9. Shafiee, D., Jafari, A. R., & Shafiee, A. A. Correlation between Interpupillary Distance and stereo acuity. *Bull. Env. Pharmacol. Life Sci*, 2014 *3*, 26-33.