



Interpupillary Distance and its Limits in South Western Nigeria

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Authors' contributions

This work was carried out in collaboration between all authors. Author JO designed the study, wrote the protocol, and wrote the first draft of the manuscript. Authors JO, BA and AOU managed the literature searches and analyses of the study and authors JO, BA, AOU, OO and LM managed the community procedures and final write up. All authors read and approved the final manuscript.

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ABSTRACT

Aim: To determine the normal and extremes of values for interpupillary distance [IPD] amongst adults in Ogun State, South Western Nigeria.

Methodology: A population based cross-sectional study. Multi-staged stratified random sampling was used to select respondents from seven Local government areas in Ogun State.

Results: One thousand two hundred and seventy four respondents were examined and each had Interpupillary distance measurements done using an automated refractor. The mean age of the study population was 41.18±20.12 years with 57.4% females. The mean IPD was 67.50±4.06 mm with a minimum value of 50mm and maximum of 84 mm. Most [75.51%] of the respondents had IPD measurements within the range of 65 mm to 74 mm. The mean IPD for males was 68.76±3.89 mm while females were 66.58±3.94 mm.

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Conclusion: The mean IPD and its upper limit obtained in this study were higher than previously documented by other studies. Inter pupillary distance increased with age and was higher in males.

Keywords: Inter pupillary distance; normal values; extreme; Ogun State.

1. INTRODUCTION

Interpupillary distance [IPD] is the distance between the centres of the pupils. It determines the degree of retinal image disparity in each eye which are combined in the brain to produce stereo perception [1].

The knowledge of the normal IPD range is important in diagnosing certain anomalies and syndromes, thus clinicians, geneticist and maxillofacial surgeons constantly consider abnormal ocular features such as hypertelorism and hypotelorism [2]. Interpupillary distance has been shown to be well correlated with temple width [3].

In the optical industry, the importance of IPD is seen in the production of spectacle frames and lenses [2] and especially considered in presbyopic corrections, high refractive errors correction and in children spectacles to prevent prismatic effects caused by decentration [4].

It's importance is also seen in the production of binocular ophthalmic and non-ophthalmic equipments eg Slit lamp, operating microscope, binocular indirect ophthalmoscope, laboratory microscope and certain audio visual display instruments.

The anatomical IPD can either be measured manually or via an automated method. Manually, this can be done with a millimetre or PD ruler placed across the patient's nose bridge and the patient asked to look at the examiners left eye. The zero of the rule is aligned with the limbus of the patients right eye [which will be looking straight ahead at the examiners left eye].The patient is then instructed to look at the examiners right eye and the position of the temporal limbus of the patient is noted [3] or alternatively, with a fixation light held by the examiner in front of the patient, the distance between the corneal light reflexes is measured and recorded in millimetres [4].

The automated method is usually done via an automated refractor or kerato-refractor. In everyday spectacle making, the important distance to note is that between the visual axes

for distant vision which is approximately 1mm less than the anatomical IPD [4].

The mean IPD have been reported as 60.5 mm [5], 62.1 mm [6], 63 mm [7], and 63.7 [8] with a documented range of between 50 mm to 75 mm [8].

The IPD has also been shown to vary with age, sex and probably race [2,7,8]. Ashin et al. [8] showed that IPD increases by 60% from a mean of 40 mm in neonates to a mean of about 65mm in adults but most of this increase was seen in the first year of life.

With gender variation, Evereklioglu et al. [2] studied 3448 subjects and showed that IPD increased markedly up to age 19 years in males and 14 years in females, reflecting early maturation in females compared to males even though males had higher values per age group. Another study showed a 3% increase in IPD from the mid-teens to later middle age in both males and females but more marked in females. This was attributed to the gender specific changes post puberty of the cranial skeletal anatomy and in the soft tissues of the orbital region [9]. While another study showed a steady increase till about 30 years of age [2].

There is no previous documentation on the normative values of the IPD measurement in Ogun State, Nigeria and this is the justification for this study. The main objectives of this study is to determine the mean, extremes and variation of IPD with age and gender in adults of Ogun State, Nigeria.

2. METHODOLOGY

2.1 Background Information on Study Area

Ogun state is located in South West Nigeria with its capital in Abeokuta and covers an area of 16,762 km [2] between latitude 6.2°N and 7.8°N and longitude 3.0°E and 5.0°E. The State is bounded by Lagos State to the South, Oyo and Osun State in the North, Ondo State to the East and the Republic of Benin to the West [10].

The state is made up of twenty Local Government Areas [LGA], out of which seven were randomly selected for community medical outreach and subsequently this study.

2.2 Study Population

The study population were adults aged 18 years and above who have been residing in the study area for at least six months and met the inclusion criteria for the study.

2.3 Inclusion Criteria

Individuals aged 18 years and above with no known ocular pathology especially corneal pathology and other media opacities to allow for IPD measurement with an automated refractor.

2.4 Exclusion Criteria

History of severe ocular trauma, craniofacial abnormalities, poor cooperation which made IPD measurement with the refractor impossible.

2.5 Study Design

A cross sectional survey of 1274 randomly selected healthy respondents out of the 2905 respondents seen at the medical outreach camps carried out in 7 [Ikenne, Ijebu North, Odogbolu, Sagamu, Ijebu Ode, Obafemi Owode, Ijebu North- east LGA] out of the 20 LGA's in Ogun State between march 2013 and September 2013.

All respondents underwent refractive error and distant IPD measurements using an automated refractor [PAK 2000, China]. The refractor took 5 consecutive readings in each eye and gave the average in millimetres.

Data collection and statistical analysis were performed using SPSS version 16 and significance level was set at $p < 0.05$.

2.6 Ethical Issues

Informed consent was obtained from all respondents and all procedures were carried out according to the Declaration of Helsinki.

3. RESULTS

One thousand two hundred and seventy four respondents had IPD measurements done, with a female preponderance of 57.4% [735]. The mean age of the respondents was 41.18 ± 20.12

years [range: 18-100] with a median and mode of 40 years and 18 years respectively.

Nine hundred and ninety five [78.1%] of the respondents were of the Yoruba tribe [one of the 3 main tribes in Nigeria], while others were from Benue and Igbo land. Visual acuity [VA] in the right eye was at least 6/18 in 80% [1019] of the respondents and worse than 3/60 in 9% [115] while in the left eye, 83.1% [1139] had VA of at least 6/18 and 7.7% [105] were worse than 3/60 (Table 1).

The mean IPD of the respondents was 67.50 ± 4.06 mm [range: 50-84] with a median and mode of 67 mm and 65 mm respectively. Six hundred and ten [47.9%] respondents had IPD within 65 mm to 69 mm, 352 [27.6%] were within 70 mm to 74 mm while 245 [19.2%] were within 60 mm to 64 mm (Fig. 1).

On classification of the IPD into Low [50 mm-60 mm], medium or average [61 mm-70 mm] and High [>70 mm], nine hundred and thirty eight [73.7%] had average IPD values while 292 [22.9%] were high and 44[3.3%] were low.

Table 1. Visual acuity of respondents

Visual acuity	Right eye	Lefteye
	Frequency [%]	Frequency [%]
$\geq 6/18$	1019 [80%]	1139 [83.1%]
$< 6/18-6/60$	134 [10.5%]	122 [8.9%]
$<6/60-3/60$	6 [0.5%]	5 [0.4%]
$< 3/60$	115 [9.0%]	105 [7.7%]
Total	1274	100.0

3.1 Variation of IPD with Age

Three hundred and thirty eight [26.5%] respondents were between 18 years and 20 years, 224 [17.6%] were between 41 years and 50 years 219 [17.1%] were older than 60 years, 184 [14.4%] were between 21 years and 30 years, 164 [12.8%] were between 51 years and 60years while 145 [11.4%] were between 31 years and 40years of age (Fig. 2).

Mean inter pupillary distance showed a significant increase with age up till 60 years, but between the 5th and 6th decade, a decrease of 9.91mm was noticed and thereafter another increment of 10.81 mm (Fig. 2).

Fig. 3 shows a five interval distribution of IPD by age groups. Across the age groups, most respondents had IPD values between 65-69mm

while the upper limits [80 mm-84 mm] of IPD values were seen after the fourth decade of life.

Correlation analysis between age and IPD of the respondents showed a statistically significant [p=0.00] positive association which was also significant amongst both males and females but

the correlation coefficient was low [r=0.12] indicating a poor correlation. Fig. 4 shows the scatter plot depicting this positive association between age and IPD, meaning IPD increased with age of respondents. It also shows the line of fit but the coefficient of determination [R²=0.015] was low.

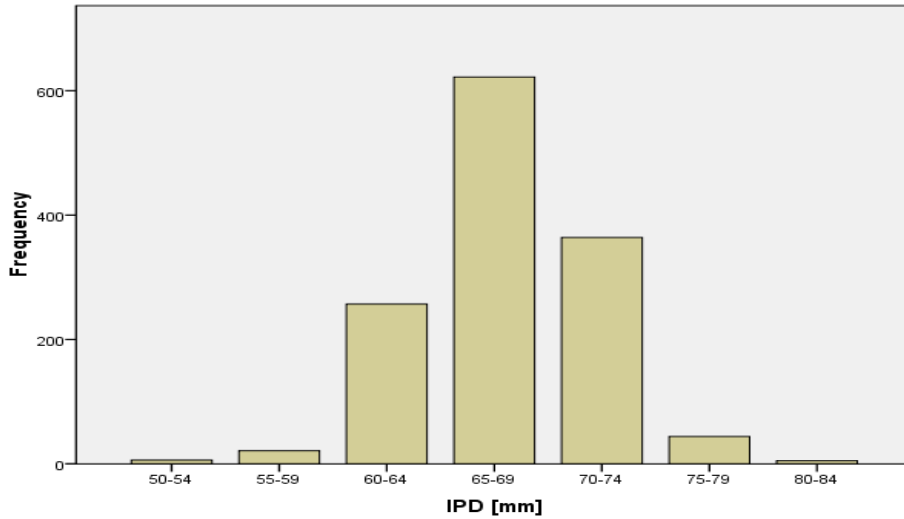


Fig. 1. Interpupillary distance distribution in respondent

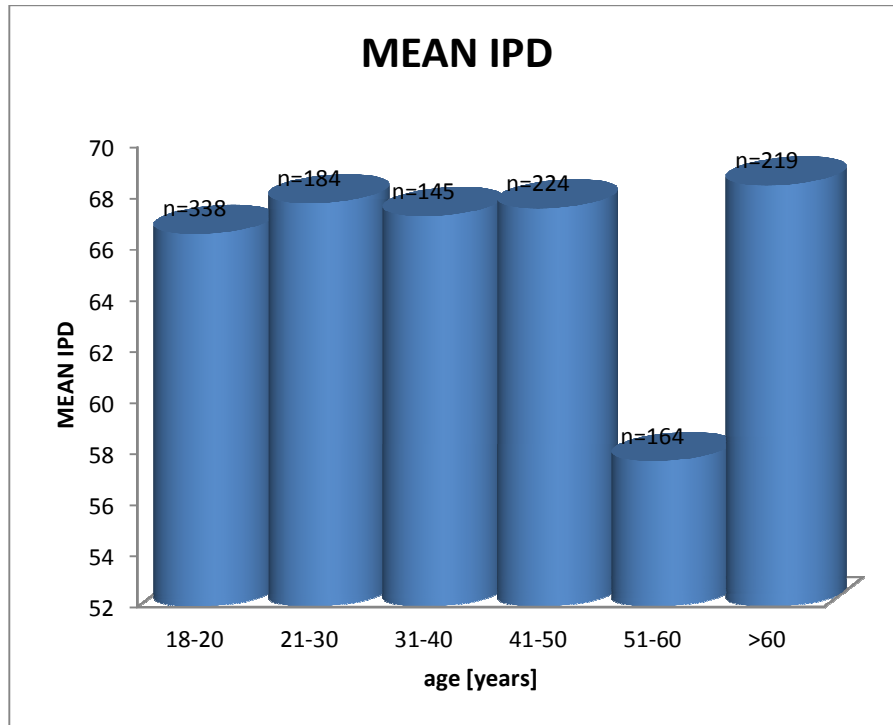


Fig. 2. Variation of mean interpupillary distance with age of respondents
 Mean IPD [Interpupillary distance in mm], n=frequency

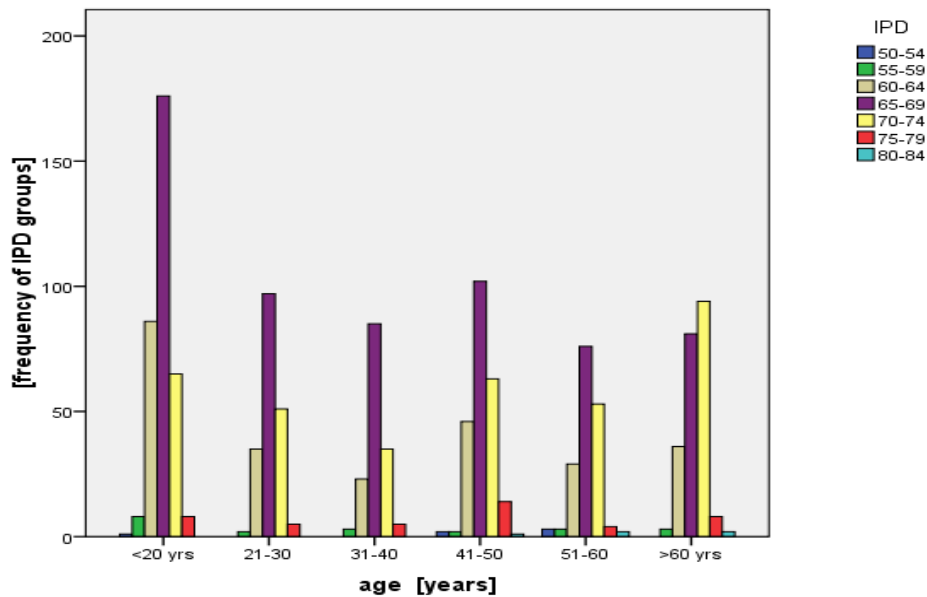


Fig. 3. Cluster chart of ipd with age of respondents

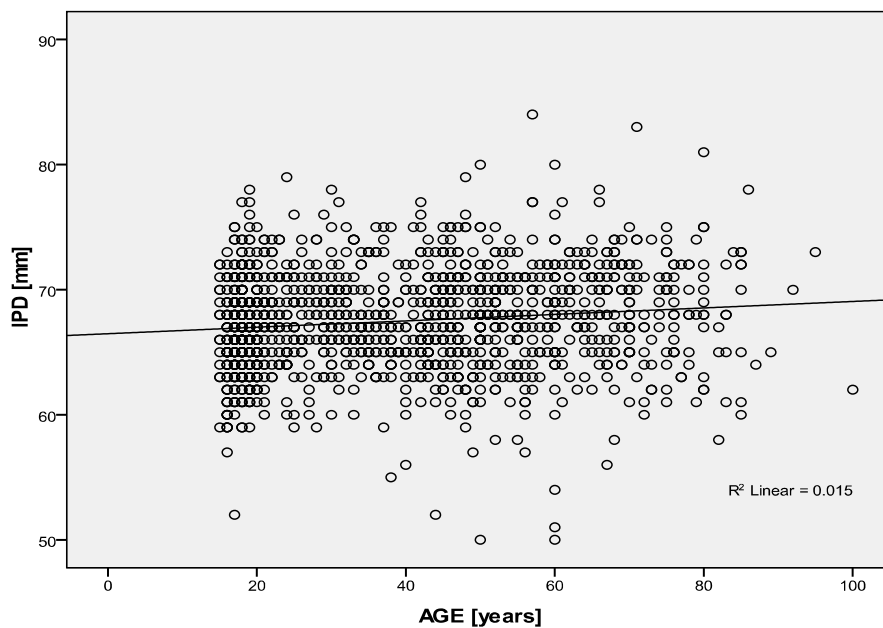


Fig. 4. Scatter plot of age and ipd of respondents

3.2 Variation of IPD with Gender

Males had a higher mean IPD of 68.76 ± 3.89 mm [range: 54-84] with a median and mode of 69.0 mm and 71.0 mm respectively, while females had a mean of 66.58 ± 3.94 mm [range 50-81] with a median and mode of 66.0 mm and 65 mm respectively.

Of the females, 53.06% [390] had IPD within 65-69 mm, 24.62% [181] were within 60-64 mm and 18.10% [133] were within 70-74 mm while for males, 40.81% [220] were within 65-69 mm, 11.87% [64] were within 60-64 mm and 40.63% [219] were within 70-74 mm (Fig. 5).

Comparison of mean IPD amongst males and females was statistically significant [$P=0.00$].

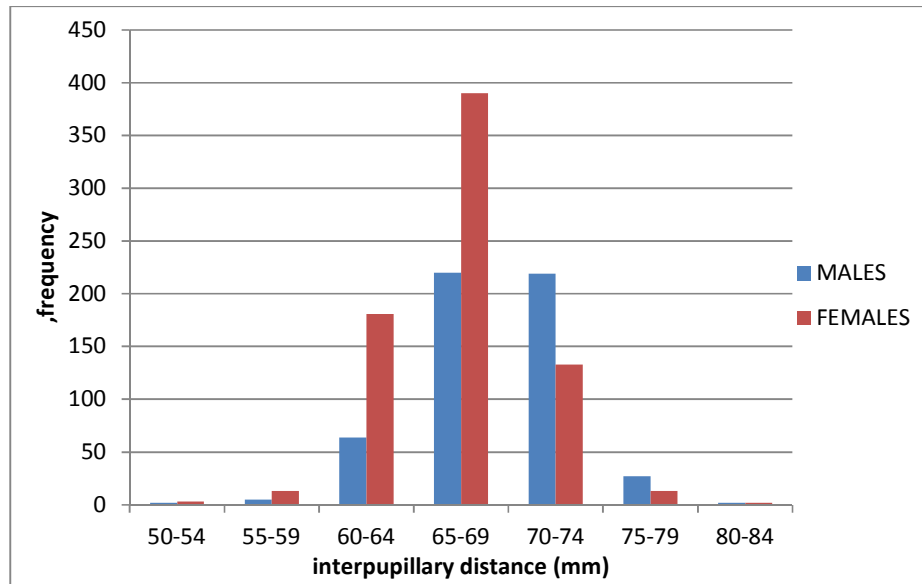


Fig. 5. Inter pupillary distance distribution by gender of respondents

4. DISCUSSION

This is a population based study which examined 1274 respondents with a female preponderance of 57.4%. Eighty percent of the respondents had a visual acuity of 6/18 and better in at least one of their eyes as also documented by the Nigeria National blindness survey [11] and Onakpoya et al. [12], while VA worse than 3/60 was seen in up to 9% of the respondents.

The average IPD for the study population was 67.50 ± 4.06 mm with a mode of 65mm, while the 65-69mm group was most prevalent across all decades until age 60 years. Interpupillary distance was measured with the aid of an automated refractor but not much information is mentioned in literature on the use of this method of IPD measurement but it is generally believed to be the most reproducible method [4]. The mean IPD obtained was higher than previously documented values in Nigeria [65.26 mm] [13], America [63 mm] [7], Iran [62.1 mm] [6] and Croatia [60.5 mm] [5].

The IPD range in this study was 50 mm to 84 mm as compared to 50 mm to 75 mm reported by Dodgson [7] and 44.1 mm to 81.29 mm reported by Usman et al. [13]. The larger upper limit of IPD [84 mm] documented in this study was close to that previously documented in the Ijaws of Nigeria [13] [81.9 mm] but much higher than previously reported in America [75 mm] [7]. This may have a racial implication and requires

more studies by different races before such a conclusion can be made. However, this should be considered in the manufacture of local ready-made bifocal spectacles and in the design of various binocular viewing and optical systems intended for use in Nigeria.

There was a statistically significant increase of 1.11 mm in IPD with age between the second and third decade of life, 0.25 mm between the fourth and fifth decades and 10.81 mm after the sixth decade (Fig. 4) but this showed a poor correlation, indicating that other factors contribute to the determination of IPD as an individual gets older. In this study, the highest increase in IPD was seen after the sixth decade and this was comparable to previous studies [2,6], thus indicating the possible presence of craniofacial structural changes with aging which may contribute to an increase in IPD as we grow older.

As in previous studies [2,6,7,13] males were noted to have a statistically significant [$p=0.00$] higher mean IPD of 68.76 ± 3.89 mm when compared to females 66.58 ± 3.94 mm. This could be because males are generally physically larger than females [14].

5. CONCLUSION

The mean IPD and its upper limit obtained in this study were higher than previously documented by other studies. Inter pupillary distance

increased with age, was higher in males and statistically significant for gender.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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