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Interpupillary Distance Measurements among Students in the Kumasi Metropolis

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Abstract

Objective: The aim was to obtain interpupillary distance (IPD) measurements of students in the Kumasi Metropolis. The study will provide a database for manufacturers of spectacle frames and optical equipment with Ghana as the target population. The IPD is a crucial measure that needs to be considered before frames can be selected for patients who have been prescribed with spectacle corrections. IPD data from other populations are unsuitable due to variations with age, sex and race.

Method: A cross-sectional study involving 500 students, aged 10 to 20 years and selected from Junior and Senior High Schools in the Kumasi Metropolis, was carried out. Interpupillary distances were measured using the pupillometer and the PD rule.

Results: Out of the 500 students, 290 (58%) were males. The study revealed that the distance and near IPD measured with pupillometer in students was 65.53 ± 3.348 mm and 61.60 ± 3.054 mm respectively. Furthermore, the IPD was 64.48 ± 3.429 mm and 62.01 ± 3.464 mm for distance and near, respectively, when measured with a PD rule.

Conclusion: IPD is affected by age, ethnicity and gender variations. The study will provide normal reference values of interpupillary distance in the Ghanaian population which will be useful to anthropometry, medicine, ophthalmic industry and primary eye care.

Keywords: Interpupillary distance; Pupillometer; PD Rule; Ophthalmic; Anthropometry

Introduction

Interpupillary distance has been defined by various authors as the distance between the centres of the pupils in millimetres [1]. It is abbreviated as PD, or more correctly, IPD [2]. IPD is the most important interorbital parameter for measuring the distance between the eyeballs [3]. It has been reported to be gender and age specific. It also differs between certain racial groups and between near and far viewing [1,4]. 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 [5]. For the principal view distances of far and near, there exists specific points on the lenses which have to coincide with the center of the pupil (visual axis) of each eye. As such, for the fitting of ophthalmic lenses, both the IPD for far and near are necessary. This is especially true when multifocal lenses are to be dispensed.

There are various ways of measuring the IPD in individuals; two commonly used ways are either manually (with a PD Rule) or by digital means (with a pupillometer). The use of the pupillometer allows an advantage of measuring monocular PDs more accurately compared to the PD Rule [6]. This is beneficial when ordering spectacles for high refractive errors or for progressive addition lenses where precise centration of each lens along the patient's visual axis is necessary [7].

In eye care practice, eye care professionals mostly measure distance IPDs of patients and by employing certain working conventions are able to approximate near IPDs. This, however, could result in complaints of eye strain in some patients due to differences in IPD when the view is changed from far to near. Globally, IPD data is scanty and there is currently no IPD data reported in literature for the Ghanaian populace. This study provides normal reference values of IPD in the Ghanaian population which could be useful in anthropometry, medicine, the ophthalmic industry and primary eye care.

Methods

Study population

A cross-sectional study involving 500 students, aged 10 to 20 years, was carried out between May 2010 and June 2010 in the Kumasi Metropolis, Ghana. The age and gender distribution of subjects recruited are shown in Table 1. Kumasi, which is the capital town of the Ashanti Region of Ghana, doubles as the second largest city in Ghana. The Kumasi Metropolis has ten [10] sub-metropolitan districts namely Asawase, Subin, Manhyia, Oforikrom, Tafo-Pankrono, Nhyiaeso, Kwadaso, Bantama, Suame, and Asokwa [8].

One out of the ten sub-metros, Oforikrom sub-metro was selected through a simple random sample for the study. Three [3] Senior High Schools [SHS] and two [2] Junior High Schools (JHS) were selected

within this sub-metro using simple random sampling and multistage Sampling techniques, respectively. In each selected school, one class out of each educational level was randomly selected. Students included in the study were apparently healthy, without any abnormal craniofacial configuration and manifest ocular deviations.

Age (years)	Male (%)	Female (%)	Total (%)
10	1	0	1
11	1	0	1
12	9	5	14
13	20	17	37
14	19	36	55
15	34	46	80
16	55	61	116
17	77	32	109
18	51	6	57
19	15	6	21
20	8	1	9
Total	290 (58)	210 (42)	500 (100)

Table 1: Age and gender distribution of students.

This research was conducted with approval from the Director of the Kumasi Metropolitan Education Directorate, the heads of the selected Junior and Senior High schools, and from the teachers. Informed consent forms were signed by parents to approve the participation of their wards.

Interpupillary distance measurements

PD rule method

Distance PD: The subject was comfortably seated such that his/her eyes were at the same level as the examiner and the pupillometer was gently placed over the subject's eyes. With the examiner and subject appropriately positioned, the examiner closed his right eye and the subject was instructed to fixate on the examiner's open 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. The nasal limbal margin was chosen as a point of reference on the patient's left eye. Without any movement of the PD 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 PD: 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.

Pupillometer method

Distance PD: The model of pupillometer used was the PD-8211 Digital PD Meter set for distance. The subject was comfortably seated such that his/her eyes were at the same level as the examiners and the pupillometer was gently placed over the subject's eyes. With the examiner looking through the pupillometer eyepiece and the patient focussing on the fixating target at the same time, the examiner aligned the cross hairs of the instrument with the subject's corneal reflex. The distance PD was recorded as the average of three readings from the instrument in millimeters (mm).

Near PD: The pupillometer was set for near and the procedure repeated as for distance. The near PD was recorded as the average of three readings from the instrument in millimetres (mm).

Data analysis

The statistical package for social scientists (SPSS) software, version 16.0, Chicago, USA, was used to analyze the collected data. Statistical tools namely, descriptive statistics and independent t-test, were employed to test gender differences in IPD. All probabilities quoted are two-sided and were considered statistically significant when less than 0.05.

	Distance IPD1 (mm)	Distance IPD2 (mm)	Near IPD1 (mm)	Near IPD2 (mm)
Mean	65.53	64.48	61.60	62.01
Standard deviation	3.348	3.429	3.054	3.464
Maximum	76.00	76.00	70.00	76.00
Minimum	56.00	55.00	52.00	52.00
Mode	66.00	64.00	61.00	62.00
Median	65.50	64.00	61.50	62.00
95% CI	65.24, 65.82	64.17, 64.78	61.33, 61.87	61.70, 62.31
5th Percentile	60.00	59.00	57.00	56.00
25th Percentile	63.50	62.00	59.50	60.00
50th Percentile	65.50	64.00	61.50	62.00
95th Percentile	71.48	70.00	67.00	68.00
99th Percentile	74.00	74.00	69.00	72.00

Table 2: Descriptive Statistics of Interpupillary distance measurements among students. *IPD 1=IPD measured using pupillometer; IPD 2=IPD measured using PD rule.

Results

The study comprised 500 students aged 10 to 20 years in which 298 (58%) were males and 210 (42%) were female subjects. The overall mean age was 15.91 ± 1.782 years (16 ± 2 years for male subjects, 15 ± 2 years for female subjects). Descriptive statistics of IPD measurements among students are displayed in Table 2. The age distribution as well as gender distribution of IPD measurements among students are shown in Tables 4 and 5 respectively. Table 3 is a comparison of IPD measurements in this study with other reported studies.

Discussion

The dimensions of the human body are known to be affected by geographical, racial, ethnic, gender and age factors. Therefore, a normative data of periocular measurements based on above factors could be indispensable in identifying ocular pathologies as well as in precisely determining the degree of deviation from the normal [13].

IPD has been reported to differ among races. Mean IPD has been quoted in the stereoscopic literature as being anything from 58 mm to 70 mm [4]. The 'international standard' for IPD is 63.5 mm [14]. However, no reference was given by the author to substantiate this claim. A study by Quant described normal IPD to be anything within 55.85-70.33 mm for males and 56.13-66.39 mm for females [16]. According to a study conducted by Pivnick [17], in which IPD was measured for a Black populations ranging from birth to 24 years, and within and between sample comparisons, made with a study by Pryor [12] among whites, Asians and Mexican-Americans, the mean IPDs recorded were statistically significantly greater in the Black population than the white population at all the age levels. Also, a study conducted by Quant [15] among a Chinese population revealed mean IPDs which were similar to that observed in a Caucassian population studied by Fledelius [17]. According to the present study, mean distance IPD measurements with the pupillometer and the PD-Rule were 65.53 ± 3.348 mm and 64.48 ± 3.429 mm respectively. These tend to agree with the normal limits given by Dodgson [4] and Quant [15] for adult IPDs. Our values were greater than those obtained by Singh [9] and Etezad-Razavi [11] among Indian populations, whilst lesser than those obtained by Oladipo et al. for a Nigerian population [12] as shown in Table 3. Therefore, normal IPD values should always be quoted for different ethnic groups as they have been shown to vary between different ethnic populations.

Population	Sex	Age	Mean ± SD (mm)	Investigator	Method employed
Indian	M F	16.5-18 15-16.5	59.10 ± 2.70 56.50 ± 2.10	9	Calculation
Ijaws (Nigeria)	M F	18-65	69.60 ± 3.75 6.64 ± 2.79	10	PD Rule
Indian	M F	3 months-20 years	57.32 ± 4.87 57.98 ± 4.78	11	Pupillometer
Japanese	M F	16-24	66.00 ± 3.40 64.00 ± 3.40	12	Calculation
Ghanaian	M F	10 - 20 12 - 20	66.11 ± 3.345 64.74 ± 3.192	Present Study	Pupillometer
Ghanaian	M F	10 - 20 12 - 20	64.96 ± 3.546 63.81 ± 3.149	Present Study	PD Rule

Table 3: Comparison of IPD among population groups.

	Males		Females	
	Mean ± SD	95% CL	Mean ± SD	95% CL
Distance IPD1 (mm)	66.11 ± 3.345	65.72, 66.49	64.74 ± 3.192	64.30, 65.17
Distance IPD2 (mm)	64.96 ± 3.546	64.55, 65.37	63.81 ± 3.149	63.38, 64.24
Near IPD1 (mm)	62.07 ± 3.082	61.71, 62.43	60.95 ± 2.899	60.56, 61.34
Near IPD2 (mm)	62.44 ± 3.619	62.02, 62.85	61.41 ± 3.149	60.99, 61.84

Table 4: Gender distribution of interpupillary distance measurements among students.

IPD has been reported to be affected by gender. Across researched ethnic backgrounds, the male IPD is on the average 2 to 3 mm wider than the female IPD [5]. A study conducted among adult Ijaws of Nigeria revealed mean IPD for males and females as 69.8 mm and 66.4 mm respectively [10]. The mean IPD measured by both instruments (for distance and near), in the current study, revealed higher IPDs in males than females as shown in Table 4. This is consistent with the findings in literature. This could be attributed to the fact that Ghanaian adult males may have larger craniofacial skeletons than females.

Age groups (years)	Distance IPD1 (mm) Mean ± SD	Distance IPD2 (mm) Mean ± SD	Near IPD1 (mm) Mean ± SD	Near IPD2 (mm) Mean ± SD
10-12	63.062 ± 3.204	62.562 ± 3.098	59.781 ± 3.055	60.000 ± 3.286
13-15	64.515 ± 3.276	63.791 ± 3.302	60.669 ± 3.030	61.346 ± 3.304
16-18	66.225 ± 3.154	64.876 ± 3.351	62.230 ± 2.884	62.390 ± 3.389
19-21	66.133 ± 3.133	65.667 ± 4.054	61.983 ± 3.150	63.267 ± 4.160

Table 5: Age Distribution of interpupillary distance measurements among students.

Our results show that mean IPD increases with age (Table 5). However, no statistical significance was found between age and IPD ($p>0.05$). A study conducted by Quant revealed that IPD decreases with increasing age [15]. A study conducted by Fledelius showed that IPD increases with age in both male and female subjects [17]. Aslin [18] showed that mean IPD increases by 60% from 40 mm in newborns to about 65 mm in adults. It has been reported that most of this change occurs in the first year of life continuing to the age of 17 and probably to age 30 [17]. Another study by Evereklioglu [19] confirmed this finding by Fledelius [17]. From Table 2, it is evident that children within our sample population tend to attain the adult IPD value as early as 10 years, as compared with the 16 to 25 year range given by Osuobeni [5]. This could be attributed to racial differences, as Ghanaian children tend to have broader and wider faces even at young ages. Hence, ethnic background should be considered as a factor in predicting the rate of IPD maturation for a certain group of people.

Conclusion

Normal values of IPD for the Ghanaian student population have been established. The IPD values are relevant for the manufacture of spectacles corrections for the Ghanaian student population.

From our results, we conclude that mean IPD is gender and age dependent, and differs between certain ethnic groups as well as between near and far viewing.

Different experimental techniques, differences in sample sizes, differences in age ranges and limited background information about study subjects hinder the generalization of IPD values for different sets of people from different ethnic backgrounds.

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