# Socio demographic Distribution of Ocular Axial Length in Port Harcourt, Nigeria.


## Abstract

**AIM:** To determine the socio demographic distribution of ocular axial length (AL) for use in estimating intraocular lens power, detect abnormal values and possibly associate them with pathological conditions.

**METHOD:** This is a community based descriptive study carried out in Port Harcourt City LGA, Nigeria of subjects 18 years of age or older and with Visual Acuity > 6/18. The major ethnic/linguistic groups in Rivers state are Ikwerre, Ogoni, Ekpeye Kalabari, Okrika, Ogba, Igbani, Obolo and Etche. Socio demographic data was obtained through a proforma. Ocular examinations done included visual acuity, applanation tonometry, and ophthalmoscopy. Axial length (AL) was measured using Amplitude (A) scan ultrasonography (SONOMED PACSCAN 300AP). Data analysis was by SPSS (Version 17), and p value was set at ≤ 0.05.

**RESULTS:** Four hundred and sixty six (466) subjects participated in the study made up of two hundred and twelve (212) males (45.5%) and two hundred and fifty four (254) females (54.5%) with M: F ratio of 1:1.2. The age range was 18-92 years and mean age of the subjects studied 43.0±14.2 years. Findings revealed mean AL to be 23.2±1.0 mm which was greater in males than females. The longest mean AL in males was seen among age group 51 and 60 years and that for females was seen in age group 41 and 50 years after which in both gender there was noticed to be a decline in mean axial lengths. There was no statistically significant relationship between age and axial length. Axial length was found to be longer in subjects with higher level of education and this pattern was statistically significant.

**CONCLUSION:** AL was significantly longer in males and has a positive relationship with the level of education of the study population. The longest mean AL in males was seen among age group 51 and 60 years and that for females was seen in age group 41 and 50 years after which in both gender there was noticed to be a decline in mean axial lengths.



**Keywords:** Socio demographic Ocular Axial Length Black Population.

## Introduction

Axial Length (AL) is an important biometric parameter in the eye, and its measurement is important in several conditions including the determination of the refractive status of the eye as well as determination of intraocular lens power for patients prior to cataract surgery[1]. It is defined as the distance between the anterior and the posterior poles of the eye or as the distance from the anterior curvature of the cornea to the retinal pigment epithelium in alignment along the optical axis of the eye.[2,3] At birth, the axial length is approximately 17-18mm; following which it increases by about 5mm (up to 23mm) from birth to age 3- 6years until it reaches an average of 24mm in adulthood.[3] Mean axial length in the Blue mountain eye study,[4] was 23.44mm, values noted for the Tanjong Pagar study,[5] in China was 23.23mm, while that gotten by Adio et al,[6] in Nigeria was 23.57mm±1.19 which is in agreement with previously documented literature. It has been found from previous studies, to be affected by age, sex and educational status [7,8,9] Refractive error, anterior chamber depth, corneal curvature and central corneal thickness are also affected by it.[10,11,12,13]Previous studies have also shown a relationship between short axial length of the eye and an increased incidence of retinal vein occlusions [14] and hypermetropia while longer axial lengths have been noted to be associated with an increased incidence of cataracts,[15] and myopia. Axial length is also said to have an influence on emmetropisation of the eye.[16] It is also the most important parameter in the calculation of intraocular lens power prior to cataract surgery, and helps in the diagnosis of pathological conditions like staphyloma and risk of retinal detachment.[7] Therefore there is a need to know the normal values of the axial length in our environment which can subsequently be used as a yardstick to detect those with abnormal values, and subsequently screen them for the associated pathological conditions.

Axial length is a quantifiable variable measured either by ultrasonography (which could be by contact or immersion techniques; amplitude (A) Scan or brightness (B) Scan) or by optical methods (Partial Coherence Interferometry).[2] The measurement of axial length using the amplitude scan is the “Gold standard” in ophthalmology, [17, 18] with values slightly differing from those of the more modern intraocular lens (IOL) master measurements. However, values obtained using the contact methods do not significantly vary from those obtained by immersion.[19] It is longer in myopes and shorter in hyperopes[3]. The axial length is the most important anthropometric variable in the calculation of Intra ocular Lens power as a 0.1mm error in its measurement will result in as much as 0.25D change in post-operative refraction.[20]

Age, gender and educational status are known factors that affect the ocular axial length values. Many cross sectional studies have shown a positive relationship between ocular axial length and age with variations in axial length also noted in the different gender. Lee et al,[8] who studied the association of age,(among other parameters) with ocular dimensions in an older white population aged 58 to 100 years, in the Beaver Dam Eye study noted that subjects younger than 65 years had longer axial lengths than those aged 75 years and older, and that larger eyes were observed in men than women. But he also noted that the adjustments for height accounted for most of the sex differences, and that age differences in axial length were attenuated although not statistically significantly, after adjustments for height. Similarly, Jivraka et al,[21] who studied variability of axial length 750 eyes of 750 patients in California USA, discovered that Axial length tended to be longer in younger patients and was inversely correlated with age and men had a longer axial length than their female counterparts. In the same vein, a study carried out by Koibuchi et al.[22] in Okinawa Japan discovered that the axial lengths for males were longer than those for females although noted that above the age of 60 years the dimension became significantly smaller.

On the other hand, Pereira et al,[23] studied ocular biometric parameters and refractive error in Brazilian adults and their relationships, in subjects aged between 21 to 70 years, and reported that , every 10 year increase in age was related to a smaller axial length of 0.15mm and that there was no influence of gender on the analyzed biometric parameter. The study nevertheless had a small sample size (n= 173) and a higher percentage of females (64.7%) which may have accounted for the lack of influence of gender

Also, Fanny A. et al,[17] who studied ocular biometric values of the black African patients in The Ivory Coast, in 325 eyes of 217 patients, discovered that men’s eyes were significantly longer than women’s eyes and stated that the reasons for the differences were several and may have been related to natural, socioeconomic or technical factors. Nothing was however mentioned on the variation of this parameter with age.

Igbinedion and Ogbeide,[24] using 400 normal eyes of 200 normal subjects, at the University of Benin Teaching Hospital, Nigeria, carried out measurements of ocular volume using Computerized Tomography. They discovered that ocular volume correlated positively with the age of the patients to about 50 years after which some reduction was observed, males were said to have larger eyeballs in comparison to females although the difference was not statistically significant. Also , Iyamu et al,[13] who carried out a study on central corneal thickness and axial length in 95 subjects aged between 20-69 years, showed that analysis of variance performed on the mean difference in axial length across the age group was not statistically significant, so also were the regression analysis on axial length and age and the mean difference between males and females.

Ogbeide et al,[25] studied ultrasonographic ocular diameters in Nigerians, in a hospital based study using 200 subjects with age range of 3-92 years, and noted a gradual increase in all eyeball diameters with age , with the highest values recorded in the older age group. He also noted that the mean diameters were slightly higher in males than females although not statistically significant. However he had a predominantly female sample (62%). This was also in keeping with the hospital based study carried out by Adio et al,[6] on ocular axial length and keratometry readings in healthy eyes of people in Southern Nigeria, using 800 eyes of 400 subjects in which she noted that the average axial length for males was slightly higher than that for females, although no variation with age was mentioned.

On the whole, several studies report positive cross sectional associations between age and axial length, with the distribution skewed to higher values in middle age.

The lower values of axial length found in females may have been as a result of differences in stature or height between females and males with most males being taller, whereas the trend of axial length with age could have been related to the fact that the globe grows rapidly from birth until the age of about 13-15 years after which growth slows significantly or stops.[23]

On the whole according to Uranchimeng et al,[26] axial length distribution is said to closely follow a Gaussian or normal distribution but is leptokurtic (i.e. the frequency distribution more concentrated around the mean than the corresponding normal distribution) with a modest right hand skew.

The influence of educational status has been noted in several studies. Uranchimeng et al,[26] on studying cultural differences in the Axial length of young adults living in Mongolia noted a 0.36mm increase ($p<0.001$) in axial length with unit increase in educational achievement (primary, secondary, and college). Similarly in the Beijing eye study,[27]higher mean axial length was significantly associated with higher level of education ($p<0.001$). Also on multivariate analysis by Hashemi et al,[7] in Iran, axial length was noted to positively correlate with years of education (P<0.001) while in the Epic- Norfolk study,[9] among British adults, axial length was noted to have the strongest significant relationship with educational attainment.

## Method

This is a community based descriptive study carried out in Port Harcourt City LGA, Nigeria of subjects 18 years of age or older and with Visual Acuity > 6/18. The major ethnic/linguistic groups in Rivers state are Ikwerre, Ogoni, Ekpeye Kalabari, Okrika, Ogba, Igbani, Obolo and Etche. Comprehensive ocular examinations done included visual acuity with Snellen's chart, intra ocular pressure with Perkin's applanation tonometer, and funduscopy with Welch Allen's ophthalmoscope. Axial length (AL) was measured using Amplitude (A) scan ultrasonography (SONOMED PACSCAN 300AP). Data analysis was by SPSS (Version 17), and p value was set at ≤ 0.05.

## RESULTS

There were two hundred and twelve (212) males (45.5%) two hundred and fifty four (254) females (54.5%) with male to female ratio of 1: 1.2 in this study.

The Ocular Axial Length (AL) values of the population studied were analysed.

The mean age of the subjects studied was 43.0±14.2 years with the age distribution between 18 and 91 years, and a peak age group of between 31 and 40 years as shown in Figure 1.

The mean age for males was 41.6 ±12.7 years and that for females 44.8+15.8 years.

The gender distribution for different ages is shown in Table 1. About one quarter of the males in the population studied, (n=54; 25.5% of total male population) were within 41 and 50 years and majority of the female population (n=83; 32.6% of female population) were within 31 and 40 years. There was a significant difference between both genders at different age groups (p= 0.01)

The mean AL of the general adult population studied was 23.2 ±1.0 mm (range 20.5 – 30.0mm). The mean distribution of AL in males was 23.6 ±1.2 mm (21.2 to 30.0 mm) and in females 22.9 ±0.7 mm (20.5 to 25.2mm). The mean difference between gender was 0.7±0.1 (95% C.I 0.5 to 0.8, t-value 7.0 and p= 0.0001).

The mean distribution in different age group between genders is shown in Figure 2.

The longest mean AL in males was seen among age group 51 and 60 years and that for females was seen in age group 41 and 50 years after which in both gender there was noticed to be a decline in mean axial lengths.

Figures 3 and 4 show the relationship between age and AL on bivariate linear regression between genders and it showed that there was no statistically significant relationship between age and axial length in both genders (p >0.05).

Axial length was found to be longer in subjects with higher level of education and this pattern was statistically significant (F-test 3.710, p= 0.006).as shown in Table 2.

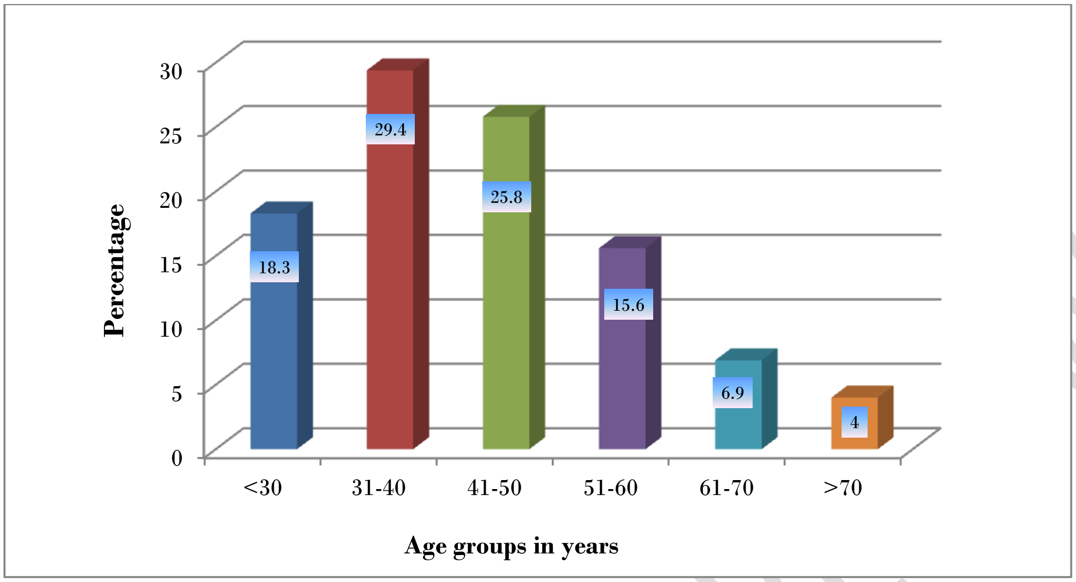



**Figure 1: Age distribution of study population**

**Table 1: Gender distribution of different age groups**

| Age groups / Gender | Male | Female | Total |
|---|---|---|---|
| | N (%) | N (%) | N (%) |
| <30 years | 43(51.2) | 41(48.8) | **84 (18.0)** |
| 31 – 40 years | 48 (36.6) | 83 (63.4) | **131 (28.1)** |
| 41 – 50years | 54 (43.5) | 70 (56.5) | **124 (26.6)** |
| 51 – 60 years | 38 (50.7) | 37 (49.3) | **75 (16.1)** |
| 61 – 70 years | 14 (42.4) | 19 (57.6) | **33 (7.1)** |
| >70 years | 15 (78.9) | 4(21.1) | **19 (4.1)** |
| **Total** | **212 (45.5)** | **254 (54.5)** | **466 (100.0)** |

**$X^2$ = 6.52, df=1, p-value 0.01**

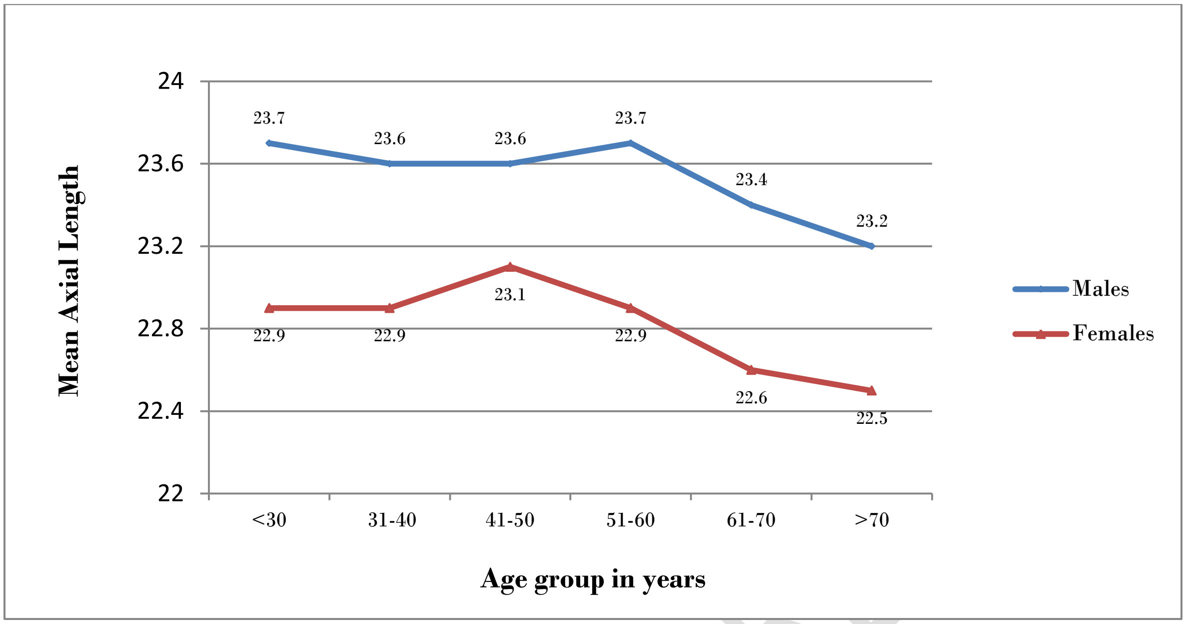
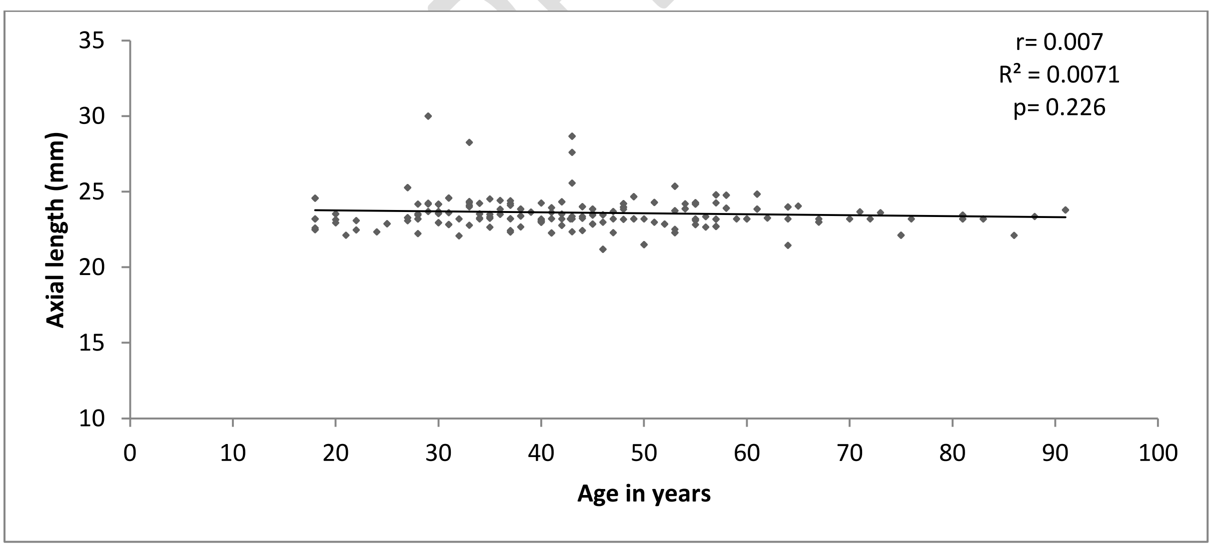
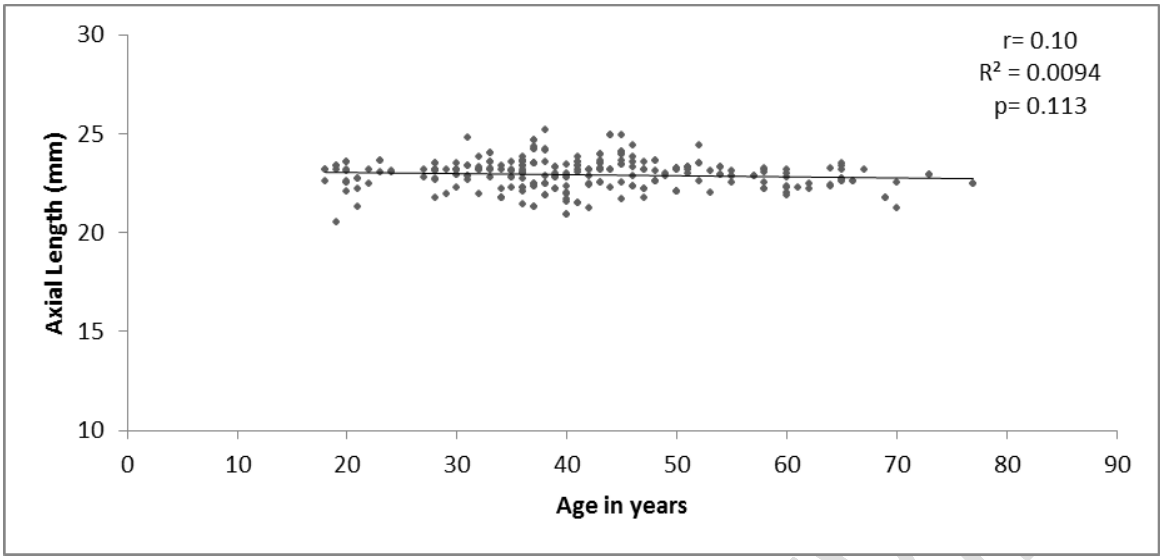



**Figure 2: Mean Axial length between genders at different age groups**




*Bivariate linear regression*

**Figure 3: Relationship between Age and Axial length in males**




*Bivariate linear regression*

**Figure 4: Relationship between Age and Axial Length in females**

**Table 2: Pattern of axial length with educational status**

| Educational status | Freq | Mean Axial length ±SD | F-test | p-value |
|---|---|---|---|---|
| No formal education | 20 | 22.5 ± 0.4 | 3.710 | 0.006 |
| Primary | 74 | 23.0 ± 1.0 | | |
| Secondary | 181 | 23.2 ± 1.1 | | |
| Tertiary | 155 | 23.4 ± 1.1 | | |
| Religious education | 36 | 23.5 ±1.0 | | |
| **Total** | **466** | **23.2 ±1.0** | | |

**One Way Analysis of Variance test**

## DISCUSSION

This study describes the socio demographic distribution ocular axial length (AL) with a view to deriving possible usable working formulae for estimating intraocular lens power for cataract surgeries in resource-challenged settings and possibly associate abnormal values with pathological conditions in normal adults in the communities of Port Harcourt City Local Government Area of Rivers State, Nigeria.

Most of the subjects studied were of Rivers ethnicity (n=184; 39.5%) which could be explained by the fact that the study was carried out in the communities that make up Port Harcourt city LGA. This was similar to the study carried out by Adio,[6] on 400 subjects in UPTH eye clinic where 56% of the subjects were from Rivers state. Most of the subjects were businessmen and women which may probably be due to the fact that Port Harcourt is largely a commercial city.

The mean axial length of the population in this study was 23.2±1.0mm which was similar to the values noted by Connell et al,[28] (23.03±1.61mm), Hashemi et al,[7](23.14mm) and the Beijing eye study,[27] (23.25±1.14). It was however slightly lower than that obtained by Adio et al (23.57±1.19 mm), and Iyamu et al,[13](23.5±0.70mm). This difference may have been attributed to the fact that the former was a hospital-based study and may not have been representative of the population. While the latter had a smaller sample size(n=95), and had an age range of 20-69 years as opposed to this study which had an age range of 18-91years. The younger age range may have attributed to the higher mean axial length since it has been noted in several studies that there is a decline in axial length with older age. The study by Iyamu et al also had a male to female ratio of 1.4:1 as opposed to this study (1:1.2). The higher proportion of males in the study by Iyamu may have further attributed to the higher mean axial length since axial length has been noted to be higher in males than females. The mean axial length in this study was also noted to be lower than that in the Central India eye study (22.66mm).this may be related to the lower height and BMI values in the Indian population (1.56±0.09m,19.37±kg/m$^2$).

In this study, males were found to have significantly longer axial lengths than females with a mean difference of 0.7±0.1mm (p=0.0001) (Figs 2, 3). This was similar to studies carried out by Adio et al,[6] in Nigeria, Hashemi et al,[7] in Iran, Lee et al,[8] in Britain and the Tanjong Pagar eye study,[5] and the Central India eye study,[1]where males were found to have higher axial lengths than females but dissimilar to the Beijing eye study where there was no statistically significant difference between the axial length in males and females and the study on Nigerians by Iyamu et al,[13]where the mean axial length in females was higher than that in males. This difference in pattern may have been due to the fact that the sample size in the study by Iyamu was small (n=95) with a smaller proportion of female. The age range of the sampled females is also not known as this may have affected the relative mean axial length if the females in the population were younger.

The longest axial length in males in this study was seen within age group 51 to 60 years which was similar to that found by Lee et al,[8] who stated that adults younger than 65 years had larger eyes than those aged 75 years and above while in females the longest mean axial lengths were noticed amongst the age group 41 to 50 years similar to that obtained by the Tanjong Pagar eye study.

There was no statistically significant relationship between axial length and age in both gender on bivariate linear analysis in this study (Figs 3 and 4), this was similar to the results got by Iyamu et al,[13] where regression analysis performed on axial length and age showed no statistical significance (p=0.46), and Connell et al,[28] in Eritrean eyes who stated that there was no correlation between age and biometric readings of his subjects.

In this study, ocular axial length was found to be longer in those with higher levels of education (p= 0.006) (see Table 2). This was in agreement with results obtained from studies carried out in other parts of the world where positive associations were noted between axial length and level of education.[7,9,26,27] In the study by Hashemi et al[7], AL increased by a coefficient of 0.011 on multivariate analysis for each year of education, this was similar to results noted by Foster et al,[9] where a coefficient of 0.21 was noted per increase in educational level and the study by Uranchimeg et al,[26] an increase in AL of 0.36mm was noted per rise in educational level (coefficient 0.19-0.52). However, from this study although regression analysis was not done on the relationship, those with no formal education were noted to have the shortest eyes. Those with tertiary and religious education were at par with each other with Religious education being slightly higher. This may be explained by the fact that most people with religious education may have had some form of prior tertiary education or that the religious education may be considered a form of tertiary education.

**Conclusion**

AL was significantly longer in males and has a positive relationship with the level of education of the study population. The longest mean AL in males was seen among age group 51 and 60 years and that for females was seen in age group 41 and 50 years after which in both gender there was noticed to be a decline in mean axial lengths

Ethical approval and consent:

Ethical clearance was obtained from relevant authorities. Socio demographic data and consent were obtained through an interviewer based Performa.

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