Original Article

Association of Refractive Errors with Axial Length and Anterior Chamber Depth in Different Age Groups

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Farnaz Siddiqui[1], Saba Al-Khairy[2], Asad Azeem Mirza[3], Muhammad Nizamuddin[4], Mahad Baig[5]
[1,4,5]Dow International Medical College, DIMC. 2,3Dow Medical College DMC

ABSTRACT

Purpose: To determine association of refractive errors with axial length and anterior chamber depth in different age groups.

Study Design: Cross-sectional study.

Place and Duration of Study: Ophthalmology Department of Dow University Hospital (Ojha campus), Dow International Medical College, Dow University of Health Sciences, Karachi, Pakistan from October 2020 to December 2020.

Methods: Eighty-three individuals of different age groups ranging from 11-80 years were included in the study. Ocular measurements including refractive error, axial length, and anterior chamber depth were determined in all participants. The association of refractive error with anterior chamber depth and axial length was tested by using two independent sample t test, Mann-Whitney U test and ANOVA.

Results: Among 83 individuals, males were 42.2% (n=35) and females were 57.8% (n=48). Most common type of refractive error was astigmatism which was found in 48.2% (n=40) participants. The overall average depth of anterior chamber (mm) and average axial length (mm) were 3.11±0.39 and 23.27±0.87 respectively. Mean differences in anterior chamber depth were statistically significant among different age groups ($p\ value < 0.001$). Statistically significant differences in mean axial length were found among different refractive errors ($p\ value = 0.001$).

Conclusion: There is a significant relation of different refractive errors with axial length and anterior chamber depth and it can be helpful in explaining the risk factors of different ocular diseases as well as it can also be helpful in clinical and diagnostic purposes in ophthalmology.

Key words: Refractive error, Axial length, Anterior chamber depth, Myopia, Hypermetropia, Astigmatism.

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Correspondence: Farnaz Siddiqui
Dow International Medical College, DIMC
Email: farnaz.siddiqui@duhs.edu.pk

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INTRODUCTION

Visual impairment is a major concern for public health worldwide, affecting people of all ages. As we grow older, uncorrected refractive errors become the primary cause of vision problems, highlighting the importance of addressing this issue across different age groups.[1] Refractive errors are closely linked to various parameters, including the axial length, anterior chamber depth, lens thickness and lens opalescence.[2] These basic anatomical parameters are also useful in diagnosing ocular pathological conditions.

Axial length refers to the distance measured from the anterior corneal surface to the posterior retinal pigment epithelium/Bruch's membrane.[3] The average axial length of a full-term newborn typically ranges

from 16 to 18 millimeters.[4] As individuals grow into adulthood, this measurement generally increases to a range of 22 to 25 millimeters.[5] The axial length serves as a crucial parameter in ophthalmic assessments, playing a significant role in determining refractive errors. Additionally, it serves as a valuable diagnostic tool for identifying ophthalmic conditions like staphyloma and assessing the risk of retinal detachment.[6] Myopic eyes typically exhibit characteristics such as greater axial length, deeper anterior chamber, and increased vitreous depth compared to non-myopic eyes. Myopia is one of the risk factors for open-angle glaucoma.[7] Hypermetropic eyes have a risk for close-angle glaucoma due to short axial length and shallow anterior chamber depth. Several studies have been conducted to see the relation of ocular biometrics especially the axial length with refractive errors.[8]

This study aimed to determine the refractive error and its association with axial length and anterior chamber depth in different age groups in patients presenting to the outpatient department of Dow University Hospital, Ojha campus.

METHODS

The research was undertaken at the Ophthalmology department of Dow University Hospital, situated within Dow International Medical College in Karachi, Pakistan. A total of 166 eyes of 83 patients were examined after obtaining informed consent. Participants were included through a convenient sampling technique. Inclusion criteria were; individuals of age ranging from 11 to 80 years, normal findings on slit lamp and fundus examination, and absence of uncontrolled systemic illness like diabetes mellitus and hypertension. Exclusion criteria were history of active ocular infection and inflammation, contact lens wearing, history of previous ocular trauma and ocular surgeries. Each participant underwent a comprehensive ocular evaluation, encompassing assessments such as visual acuity and refraction measurement; slit lamp examination of the anterior segment, fundoscopy, as well as measurement of anterior chamber depth and axial length. A well-trained optometrist assessed the visual acuity by using Snellen's visual acuity chart and auto refraction by auto refractometer (Topcon RM-880D, Japan) for refractive errors. Slit lamp examination was done to rule out anterior segment pathologies. Fundoscopy was performed using slit lamp biomicroscopy, employing a 90D lens to evaluate vitreous and retinal pathologies. Anterior chamber depth was measured in millimeters, and axial length was assessed using A-scan ultrasonography (COMPAQ). The sample size for this study is 108 minimum. Taking prevalence of refractive error as 34.9%, the sample size was calculated with open epi version 3 with 95% CI, and the power of the study as 80.[9]

The data analysis was conducted utilizing the SPSS version 16.0. Categorical variables were expressed in percentages and frequencies, while continuous variables were summarized using means, standard deviations, medians, and interquartile ranges. The normality assumption for quantitative variables was assessed via the Shapiro-Wilk test. For characteristics such as axial length and chamber depth, the average of measurements from the right and left eyes was utilized.

Comparisons of mean chamber depth and axial length across genders, age groups, and different types of refractive errors were performed using two independent t-tests, Mann-Whitney U test, and One-way ANOVA Results with p-values less than or equal to 0.05 were deemed statistically significant.

RESULTS

Among 83 individuals, 35 individuals (42.2%) were males and 48 (57.8%) of the sample, were females. Majority of the participants had ages between fifty-one to eighty years (34.9%, n=29), followed by thirty-one to fifty years (33.7%, n=28) and eleven to thirty years (31.3%, n=26). The most common type of refractive error was astigmatism which was found in 48.2% (n=40) participants. Elderly females aged from fifty-one to eighty years were more prone to have astigmatism (62.5%, n=10) as compared to males (38.5%, n=5) of the same age group. Males between 31 and 50 years had relatively high proportions of myopic eyes (30.8%, n=4) and Hypermetropic eyes (38.5%, n=5) as compared to females of the same age group (See Table 1).

The overall average depth of chamber (mm) and average axial length (mm) were 3.11±0.39 and 23.27±0.87 respectively. It was found that participants between 51 and 80 years had lower mean anterior chamber depth as compared to those who belonged to younger age groups. Statistically significant differences in mean anterior chamber depth were observed across various age groups($pvalue \leq 0.05$).

Table 1: *Gender distribution in different refractive errors with respect to age groups (n=83).*

Characteristics	Total	Refractive Error Type Hypermetropia (n = 17) n (%)	Myopia (n = 26) n (%)	Astigmatism (n = 40) n (%)
Gender				
Female				
Age (years)				
11 – 30	17	0 (0)	9 (52.9)	8 (47.1)
31 – 50	15	5 (33.3)	2 (13.3)	8 (53.3)
51 – 80	16	4 (25.0)	2 (12.5)	10 (62.5)
Male				
Age (years)				
11 – 30	9	0 (0)	4 (44.4)	5 (55.6)
31 – 50	13	5 (38.5)	4 (30.8)	4 (30.8)
51 – 80	13	3 (23.1)	5 (38.5)	5 (38.5)

Table 2: *Association of average chamber depth (mm) with different refractive errors (n=83).*

Characteristics	Average Chamber Depth (mm)		p-value
	Mean ± SD	Median (IQR)	
Gender			
Female	3.05 ± 0.41	3.05 (0.60)	0.140*
Male	3.18 ± 0.38	3.14 (0.57)	
Age (years)			
11 – 30	3.36 ± 0.36	3.37 (0.55)	
31 – 50	3.08 ± 0.31	3.05 (0.50)	< 0.001**
51 – 80	2.91 ± 0.40	2.87 (0.66)	
Refractive error type			
Hypermetropic	2.96 ± 0.32	3.04 (0.50)	
Myopia	3.21 ± 0.39	3.33 (0.52)	0.138**
Astigmatism	3.11 ± 0.42	3.01 (0.61)	

*Two independent samples t test.
** One-way ANOVA.

Table 3: *Association of average axial length (mm) with different refractive errors (n=83).*

Characteristics	Average Axial length (mm)		p-value
	Mean ± SD	Median (IQR)	
Gender			
Female	23.10 ± 0.89	23.15 (1.03)	0.033*
Male	23.51 ± 0.80	23.42 (0.90)	
Age (years)			
11 – 30	23.59 ± 0.86	23.40 (1.10)	
31 – 50	23.12 ± 0.82	23.09 (0.82)	0.086**
51 – 80	23.15 ± 0.90	23.16 (1.07)	
Refractive error type			
Hypermetropic	22.71 ± 0.64	22.68 (1.03)	
Myopia	23.67 ± 0.86	23.45 (1.10)	0.001**
Astigmatism	23.26 ± 0.85	23.25 (0.69)	

*Mann-Whitney U test
** One-way ANOVA.

Mean anterior chamber depth (mm) of Hypermetropic eyes (2.96±0.32) was lower than other types of refractive errors (See Table 2).

Males exhibited significantly longer axial length compared to females ($p\ value = 0.033$).Statistically significant differences in mean axial length were found among different refractive errors ($p\ value = 0.001$) where it was found to be higher in patients who had myopic eyes.All types of refractive errors had significant mean axial length differences where the highest mean difference was found in between Hypermetropic and myopic eyes (Mean difference = 0.96 mm($p\ value \leq 0.001$) (See Table 3). The axial length was correlated with the anterior chamber depth, R=0.73 and p-value <0.001.

DISCUSSION

Different ocular parameters are required in the clinical and diagnostic field of Ophthalmology. The axial length serves as a significant anatomical metric and a useful indicator for refractive errors. Additionally, it aids ophthalmologists in identifying various ocular

conditions, including staphyloma and the potential for retinal detachment.[10] The findings of the present study revealed that astigmatism emerged as the predominant type of refractive error observed in 48.2% (n=40) participants in both genders. Females between 51 and 80 years were more prone to have astigmatism (62.5%, n=10) as compared to males (38.5%, n=5) of the same age group. Male of age ranging from 31-50 years had relatively high proportions of having myopic eyes 30.8%, (n=4) as compared to females of the same age group. A study conducted in Bangladeshi adults showed that myopia was more in men as compared to women.[11] The study conducted in the Iranian, in South Africa, and Indian population showed that Hypermetropic was more common in the females.[12-14] Disparities in race, ethnicity, and genetic factors can probably explain the difference in refractive error.

In our study, the average anterior chamber depth (ACD) among females was 3.05±0.41 while in males it was 3.18±0.38 which is slightly greater than the females. The mean ACD of both genders in our study was comparable to data of mean ACD of multiple other studies.[15] The average ACD in previous studies were approximately 3.08±0.34 in women and 3.20±0.37 in men which were similar to our study.[16]In the present study, the average ACD decreased with the increase in age. This decrease in ACD with increasing age may be due to an increase in the lens size because of protein fiber layers forming under the capsule due to aging which was demonstrated by other studies.[17] The mean ACD in myopic eyes was 3.21±0.39 and in Hypermetropic eyes were 2.96±0.32. This showed that myopic eyes had deep anterior chamber depth and hypermetropic eyes had shallower anterior chamber depth. The results proved the association of Open-angle glaucoma and Closed-angle glaucoma with myopia and hypermetropia respectively.

The average axial length in males was 23.51±0.80 while in females was 23.10±0.89 which was comparable to another study in which the mean axial length in males was 23.68±1.06 and in females was 23.23±1.10.[18] In our study, the younger participants aged between 11-30 years had a longer axial length of 23.59±0.86 as compared to middle and older-aged participants which is also similar to other study results.[19] This age-specific change in axial length is because of an increase in the size of eyes in the growing age and middle and older age it shows insignificant changes in axial length. In the present research, myopic eyes had a greater axial length of 23.67±0.86 as compared to the axial length of hypermetropic eyes of 22.71±0.64 which is a statistically significant difference of mean axial length of both refractive errors. Similar results were noticed in Singapore India Eye study[17] and the Meiktila Eye study.[20,21] In our study a strong correlation was found between axial length and anterior chamber depth, similar to study by Zhang et al.[22]

Limitation of our study was a single center study which presents only a small sample of our population. Larger studies with different ethnic groups need to be conducted for generalization of results.

CONCLUSION

The outcome of this research showed a significant relation between different refractive errors with axial length and anterior chamber depth and by the help of these ocular parameters it can be helpful in explaining the risk factors of different ocular diseases which are associated with ocular dimensions and can also be helpful in clinical and diagnostic purposes in ophthalmology.

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Patient's Consent: Researchers followed the guidelines set forth in the Declaration of Helsinki.

Conflict of Interest: Authors declared no conflict of interest.

Ethical Approval: The study was approved by the Institutional review board/Ethical review board **(IRB-3217/DUHS/Approval/2023/441)**.

REFERENCES

1. **Sao Babawo L, Saccoh AF, Kpaka RB.** Understanding vision impairment: a comprehensive study of uncorrected refractive errors among primary school teachers and pupils in non gowa chiefdom, kenema district, sierraleone. Midwifery. 2024;**7(2):**20-46. Doi: 10.52589/AJHNM-8RXGK66G.
2. **Meng J, Wei L, He W, Qi J, Lu Y, Zhu X.** Lens thickness and associated ocular biometric factors among cataract patients in Shanghai. Eye and Vision. 2021;**8:**1-9. Doi: 10.1186/s40662-021-00245-3.

3. **Ali ZH, Abdulkareem SA.** Measurement of Axial Length by Applanation Ultrasound Relative to Optical Biometry in Normal Eye. Iraqi Postgraduate Med J.2021;**20(1)**.
4. **Groot AL, Lissenberg-Witte BI, van Rijn LJ, Hartong DT.** Meta-analysis of ocular axial length in newborns and infants up to 3 years of age. Surv Ophthalmol. 2022;**67(2):**342-352. Doi: 10.1016/j.survophthal.2021.05.010.
5. **Nilagiri VK, Lee SS, Lingham G, Charng J, Yazar S, Hewitt AW, et al.** Distribution of Axial Length in Australians of Different Age Groups, Ethnicities, and Refractive Errors. Transl Vis Sci Technol. 2023;**12(8):**14. Doi: 10.1167/tvst.12.8.14.
6. **Park S, Park K, Yang S, Byon IS, Lee JE, Park SW.** Diagnosis of posterior staphyloma using the radius of steepest curvature among retinal pigment epithelium segmentation line measured by optic coherent tomography. BMC Ophthalmol. 2024;**24(1):**58. Doi: 10.1186/s12886-024-03321-z.
7. **Al-Essa RS, Turjoman AA.** Acute Attack of Primary Angle Closure in a Highly Axially Myopic Eye: A Case Report. Am J Case Rep. 202123;**22:**e931002. Doi: 10.12659/AJCR.931002.
8. **Bikbov MM, Kazakbaeva GM, Fakhretdinova AA, Tuliakova AM, Iakupova EM, Panda-Jonas S, et al.** Associations between axial length, corneal refractive power and lens thickness in children and adolescents: The Ural Children Eye Study. Acta Ophthalmol. 2024;**102(1):**e94-e104. Doi: 10.1111/aos.15692.
9. **Shah SP, Jadoon MZ, Dineen B, Bourne RR, Johnson GJ, Gilbert CE, et al.** Refractive errors in the adult Pakistani population: the national blindness and visual impairment survey. Ophth Epidemiol. 2008;**15(3):**183-190. Doi: 10.1080/09286580802105822.
10. **Pugazhendhi S, Ambati B, Hunter AA.** Pathogenesis and prevention of worsening axial elongation in pathological myopia. Clin Ophthalmol. 2020:853-73. Doi:10.2147/OPTH.S241435.
11. **RR B.** Prevalence of refractive error in Bangladeshi adults: results of the National Blindness and low vision survey of Bangladesh. Ophthalmology. 2004;**111:**1150-1160. Doi: 10.1016/j.ophtha.2003.09.046.
12. **Yekta AA, Fotouhi A, Khabazkhoob M, Hashemi H, Ostadimoghaddam H, Heravian J, et al.** The prevalence of refractive errors and its determinants in the elderly population of Mashhad, Iran. Ophth Epidemiol. 2009;**16(3):**198-203. Doi: 10.1080/09286580902863049.
13. **Wajuihian SO, Mashige KP.** Gender and age distribution of refractive errors in an optometric clinical population. J Optom. 2021;**14(4):**315-327. Doi: 10.1016/j.optom.2020.09.002.
14. **Singh S.** A Clinical Study on Prevalence, Visual and Functional impact of Astigmatism among patients attending Out Patient Department in a tertiary care hospital in UP. Int J Life Sci Biotechnol Pharma Res. 2023;**1:**2.
15. **Taroni L, Hoffer KJ, Pellegrini M, Lupardi E, Savini G.** Comparison of the new Hoffer QST with 4 modern accurate formulas. J Cataract Refract Surg. 2023;**49(4):**378-384. Doi: 10.1097/j.jcrs.0000000000001126.
16. **Rauscher FG, Francke M, Hiemisch A, Kiess W, Michael R.** Ocular biometry in children and adolescents from 4 to 17 years: a cross-sectional study in central Germany. Ophthalmic Physiol Opt. 2021;**41(3):**496-511. Doi: 10.1111/opo.12814.
17. **Fernández J, Rodríguez-Vallejo M, Poyales F, Burguera N, Garzón N.** New method to assess the accuracy of intraocular lens power calculation formulas according to ocular biometric parameters. J Cataract Refract Surg. 2020;**46(6):**849-856. Doi:10.1097/j.jcrs.0000000000000165.
18. **Née Schoeman MN.** A comparison of arterial measurements between a South African cadaver and living sample as affected by age, sex, height and weight [dissertation]. Pretoria (South Africa): University of Pretoria; 2020. Available from: http://hdl.handle.net/2263/79017. Accessed: 29 August 2024.
19. **Rozema JJ, Ní Dhubhghaill S.** Age-related axial length changes in adults: a review. Ophthalmic Physiol Opt. 2020;**40(6):**710-717. Doi: 10.1111/opo.12728.
20. **Cegarra M, Alonso L, Rahhal M, JA SG.** Consolidating the anatomical relationship between ocular axial length and spherical equivalent refraction. Eur J Anat. 2024;**5(3):**145-150.
21. **Sun Y, Wei S, Li S, Cao K, Hu J, Yang X, et al.** Distribution of ocular biometry in young Chinese eyes: the Anyang University Students Eye Study. Act Ophthalmol. 2021;**99(6):**621-627. Doi: 10.1111/aos.14710.
22. **Zhang Z, Mu J, Wei J, Geng H, Liu C, Yi W, et al.** Correlation between refractive errors and ocular biometric parameters in children and adolescents: a systematic review and meta-analysis. BMC Ophthalmol. 2023;**23(1):**472. Doi:10.1186/s12886-023-03222-7.

Authors Designation and Contribution

Farnaz Siddiqui; Associate Professor: *Concepts, literature search, Data acquisition, Data analysis, Statistical analysis, Manuscript preparation, Manuscript editing.*

Saba Al-Khairy; Assistant Professor: *Concepts, Data acquisition, Data analysis, Statistical analysis.*

Asad Azeem Mirza; Assistant Professor: *Concepts, Data acquisition, Data analysis, Manuscript preparation.*

Muhammad Nizam-ud-Din; Medical Officer: *Literature search, Data acquisition, Data analysis, Manuscript preparation.*

Mahad Baig; House Officer: *Design, Data acquisition, Manuscript review.*