Correlation Study of Axial Ocular Parameters with Height among Emmetropic Candidates appearing for Medical Evaluation

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Abstract

Aim: The aim of our study was to determine any correlation between age, height, and ocular biometric variables, namely, pachymetry (central corneal thickness [CCT]), axial length (AL), and anterior chamber depth (ACD) in candidates appearing for medical evaluation.

Materials and methods: This was a cross-sectional, observational study conducted among the candidates reporting to a medical evaluation center of the Indian Air Force (IAF) for selection to military duties. A total of 724 emmetropic eyes of 362 candidates in the age group of 16–30 years were studied. All candidates were evaluated for AL, ACD, CCT, and height was measured. The data was analyzed by inferential statistics like unpaired *t*-test and Kruskal–Wallis test, followed by testing of Pearson's correlation coefficient *r*. The *p*-value < 0.05 is considered statistically significant.

Results: A total of 334 males and 28 females were enlisted in this study. The mean height of males and females was 174.45 ± 6.510 and 159.04 ± 3.837 cm, respectively. The mean AL (23.73 vs 23.14 mm, $p < 0.001$) and CCT (512.88 vs 504.98 μ, $p < 0.841$) were significantly greater in male candidates and ACD (3.60 vs 3.68 mm, $p < 0.229$) was more in female candidates. The mean CCT in males and females was 512.88 ± 26.978 and 504.98 ± 21.794 mm, respectively. Mann–Whitney *U* test showed that there were no significant mean difference between CCT and gender (*p* - 0.841). Kruskal–Wallis test showed that there was no significant difference between age groups and AL ($p < 0.05$). The mean AL in males and females was 23.73 ± 0.678, and 23.14 ± 0.353 mm, respectively, and there was a significant mean difference between AL and gender (*p* - 0.001). There was a statistically significant positive correlation noted between AL and height of the candidates.

Conclusion: The study revealed a positive correlation between AL and height. Individual height is one of the important parameters in assessing the fitness of candidates, along with axial biometry. Emmetropic refraction can be seen by the process of compensation or attenuation of variable axial biometric parameters. We recommend that AL criteria should be correlated with height parameters in candidates with myopia or any refractive surgeries prior to ascertaining the fitness status.

Keywords: Anterior chamber depth, Axial length, Biometry, Pachymetry.

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Introduction

The refractive status of the eye is maintained by the dynamic interplay of various ocular biometric parameters. The axial biometric parameters include AL, ACD, lens thickness (LT), and vitreous chamber depth (VCD). Evaluation of these parameters is important in screening individuals before offering any refractive or surgical corrections for individuals with refractive errors. Presently various advanced treatment modalities are available to correct refractive errors. The axial biometric parameters are identified as proven factors that significantly contribute to visual outcomes in these individuals and their subsequent fitness outcomes during selection in various branches of the armed forces.

It is imperative to have stringent entry-level medical standards for candidates appearing for selection into the armed forces owing to the complexity and demands of the profession. Periodic analysis of data on medical examination can provide valuable information regarding the nature of disabilities causing rejection and provides inputs on the adequacy of the medical policies governing such medical evaluation.

The pattern of causes of rejection in applicants pertaining to ocular biometry in eye evaluation is likely to be different between gender, age group, and height. The aim of our study was to determine any correlation between age, height, and ocular biometric variables, namely, CCT, AL, and ACD in candidates appearing for medical evaluation.

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Materials and Methods

This was a cross-sectional, observational study conducted among the candidates reporting to a medical evaluation center of the IAF for the medical examination for selection to military duties. Institutional ethical clearance and written informed consent were taken from all the candidates. The study was performed in accordance with the tenets of the Declaration of Helsinki. A total of 724 emmetropic eyes of 362 candidates in the age group of 16–30 years were studied. Candidates with previous ocular surgery, glaucoma, any corneal pathology (like a corneal scar, pterygium, and ectasia), or any disease affecting corneal thickness were excluded from the study. The height was measured in centimeters by standard method. All candidates underwent complete ophthalmological evaluation. AL and ACD were measured by intraocular lens master optical coherence biometry (M/s Carl Zeiss Meditec AG, Germany). CCT was measured by ultrasonic CCT (M/s Devine Meditech, India; probe frequency-10 MHz, velocity-1640 m/second). All measurements were taken as per the standard method by the same observer to avoid interobserver bias. Data was entered in the Excel spreadsheet. The candidates were assigned to three groups based on age parameters for better statistical analysis (16–20, 21–25, and 26–30 years).

Statistical Analysis

The statistical analysis of the data was done using SPSS (Statistical Package for Social Sciences) version 20 [IBM SPASS statistics (IBM corp. Armonk, NY, USA released 2011)]. Descriptive statistics of the variables were calculated by the mean and standard deviation for quantitative variables and for qualitative variables by estimating frequency and proportions. Inferential statistics like unpaired *t*-test and Kruskal–Wallis test were applied to test the statistical difference.

Statistical significance was declared when the *p*-value was <0.05.

Results

A total of 724 eyes of 362 candidates in the age group of 16–30 years, consisting of 334 males and 28 females, were enlisted in this study.

Table 1 provides sex-specific median height, AL, ACD, and CCT of male and female candidates. The mean height of males and females was 174.45 + 6.510 and 159.04 + 3.837 cm, respectively. Mann–Whitney *U* test showed a significant median difference between height and gender (*p* - 0.001).

The mean AL (23.73 vs 23.14 mm, $p < 0.001$) and CCT (512.88 vs 504.98 μ, $p < 0.841$) were significantly greater in male candidates and ACD (3.60 vs 3.68 mm, $p < 0.229$) was more in female candidates. The variables CCT, ACD, and AL, measured separately for both eyes, were highly correlated.

Table 2 shows the effect of age on CCT. The median CCT in the age group of 16–20, 21–25, and 26–30 years was 517.08, 511.2 and 509.44 μ, respectively. There was a significant difference between the CCT and the age groups (*p* - 0.001). The mean CCT in males and females was 512.88 ± 26.978 and 504.98 ± 21.794 mm, respectively. Mann–Whitney *U* test showed that there was no significant mean difference between CCT and gender (*p* - 0.841).

Table 3 shows the effect of age on AL. The mean AL was 23.69 mm, with a range of 22–25 mm. Kruskal–Wallis test showed that there was no significant difference between age groups and AL ($p < 0.05$). The mean AL in males and females was 23.73 ± 0.678 and 23.14 ± 0.353 mm, respectively. Mann–Whitney *U* test showed that there was a significant mean difference between AL and gender (*p* - 0.001).

Table 4 shows the effect of age on ACD. The mean ACD was 4 mm with a range of 3–4 mm. Kruskal–Wallis test showed that there was no significant difference between age groups and ACD (*p* - 0.094). The mean ACD in males and females was 3.60 ± 0.508 and 3.68 ± 0.471 mm, respectively. Mann–Whitney *U* test showed that there was no significant mean difference between ACD and gender (*p* - 0.229).

Spearman correlation (Table 5) showed that there was a negative correlation between age and variables like AL, ACD, and CCT. There was no statistical significance found between age and AL (*p* - 0.666), but statistical significance was found between age and ACD, age, and CCT ($p < 0.05$).

Spearman correlation showed that there was a positive correlation between AL and height and was statistically significant (Table 6). The correlation was found to be negative between height and ACD, but it was not statistically significant.

Discussion

Axial ocular biometry encompasses AL, ACD, LT, and VCD, out of which AL and VCD has been the most reliable indicator of refractive status. It is known that there is significant variability in ocular biometry readings beyond either end of the refractive spectrum. But the range within limits of emmetropia is not widely discussed. The same has been published in multiple regression models.[1,2] In this study, we have tried to highlight the same. We analyzed the ocular biometry in 362 emmetropic candidates who appeared for medical evaluation prior to joining various branches of the armed forces.

There exists diversity in the refractive error distribution in relation to ethnic variation due to differences in ocular biometrics. Various studies show that East Asian countries have more prevalence of myopia and astigmatism while European and American countries have more cases of hyperopia. It was observed that myopes and hyperopes have a significant variation in their mean AL showing lesser AL in hyperopic females.[3,4]

The effect of gender over refractive error and its association with AL has been extensively studied and reveals that gender differences are not statistically significant in emmetropic subjects.[5] In our study, it was found that mean AL (23.73 vs

Table 1: Sex specific median height, AL, ACD, and CCT of male and female candidates

Variables	*Gender*	*N*	*Median*	*Standard deviation*	*Mann–Whitney U test*	*p-value*
Height	Male	668	174.45	6.510	958	0.001
	Female	56	159.04	3.837		
AL	Male	668	23.73	0.678	9376	0.001
	Female	56	23.14	0.353		
ACD	Male	668	3.60	0.508	17166	0.229
	Female	56	3.68	0.471		
CCT	Male	668	512.88	26.978	18402	0.841
	Female	56	504.98	21.794		

Table 2: Effect of age on CCT

	Age group	N	Mean	Standard deviation	Minimum	Maximum	Kruskal–Wallis test	p-value
CCT	16–20	192	517.08	24.405	456	593	25.319	0.000
	21–25	330	511.20	28.221	462	612		
	26–30	202	509.44	25.680	470	612		
	Total eyes	724	512.27	26.684	456	612		

Table 3: Effect of age on AL

	Age group	N	Mean	Standard deviation	Minimum	Maximum	Kruskal–Wallis test	p-value
AL	16–20	192	23.74	0.517	23	25		
	21–25	330	23.71	0.735	22	25		
	26–30	202	23.60	0.707	22	25	4.485	0.106
	Total eyes	724	23.69	0.677	22	25		

Table 4: Effect of age on ACD

	Age group	N	Mean	Standard deviation	Minimum	Maximum	Kruskal–Wallis test	p-value
ACD	16–20	192	3.68	0.530	3	4		
	21–25	330	3.57	0.495	3	4		
	26–30	202	3.59	0.493	3	4	4.725	0.094
	Total eyes	724	3.61	0.506	3	4		

Table 5: Spearman correlation showing negative correlation between age and variables like AL, ACD, and CCT

Age	*AL*	*ACD*	*CCT*
Correlation coefficient	–0.016	–0.081*	–0.162*
p-value	0.666	0.030	0.000

*correlation is significant at the 0.05 level (2-tailed)

Table 6: Spearman correlation showing positive correlation between AL and height

Height	*AL*	*ACD*
Correlation coefficient	0.251*	–0.029
p-value	0.000	0.444

*correlation is significant at the 0.05 level (2-tailed)

23.14 mm, $p < 0.001$) and CCT (512.88 vs 504.98 μ, $p < 0.841$) were significantly greater in male candidates and ACD (3.60 vs 3.68 mm, $p < 0.229$) was more in female candidates. This was further supported by a study done in Shahroud in North Iran, where all biometric parameters were higher in males than females. Hoffer et al.[6] observed that males have significantly longer AL, deeper anterior chamber, and lower corneal power when compared to females. Similar findings were observed in a study performed in Nigeria, which noted the association between AL and ACD and found values of both parameters higher in males.[7] Eyes with increased AL were associated with a deeper anterior chamber was revealed in a study by Chen et al.[8] in normal Taiwanese Chinese adults in the age group 40–80 years, although the study did not correlate the parameters to anthropometric findings. In yet another study, it was revealed that the ACD is significantly correlated with AL in eyes with AL <24 mm but not in longer eyes.[9]

The increased ACD in females compared to males in our study could not be generalized as the sample size of female candidates in the study was very less. The Spearman correlation applied showed that there was a negative correlation between AL and variables like ACD and CCT. There was no statistical significance found between ACD and AL (p - 0.914), but statistical significance was found between AL and CCT ($p < 0.05$). This explains the status of emmetropia of the candidates in the study by process of emmetropization though there was a variation in AL, CCT, and ACD.

In relation to height, it was found that men are taller than women, with the mean height of males and females being 174.45 ± 6.510 and 159.04 ± 3.837 cm, respectively. Lyhne et al.[10] found that taller individuals had greater ACD, VCD, AL, and corneal curvature. Similar findings were found in a study performed in Australia by Ojaimi et al.[11]

A study by Roy et al. and Nangia et al.[12,13] revealed that height has a positive correlation with AL and ACD with every millimeter increase in AL; there was a 0.07 mm increase in ACD in the general population. The body height and size of the eyes were associated with each other, whereas taller subjects had larger eyes with flatter corneas. Nangia et al. found that every 10 cm increase in height was associated with a 1% increase in ACD and VCD.

Wong et al.,[14] in their study done on Singaporean Chinese individuals, found that although height and axial ocular dimensions were related, they did not influence the refraction status of individuals. They found that taller people had longer AL and deeper ACD, whereas, in our study, AL and height had a positive correlation, but ACD had a negative correlation (p-0.914). The normal consensus would expect that a taller person might have larger eyes and other ocular dimensions. Height has been found to have a strong correlation with AL being the anthropometric factor in a study conducted on Sydney school children.[11] A study by Johnson et al. observed a positive correlation between AL and height, but the association with other ocular components was not reported.[15]

In our study, there was a statistically significant (p 0.001) positive correlation noted between AL and the height of the candidates. But the height did not appear to influence the refractive state of the eyes though taller individuals had longer globes. A study of military recruits aged 17–19 years by Rosner et al. suggested there was no correlation between refraction and stature.[16] This observation supports the concept of emmetropization discussed in studies by Brown et al.[3] and Lyhne et al.,[10] which involves interaction between individual biometric components. Though the study reveals a positive correlation between height and AL, the effect of other components, ACD, and CCT, appears to have either compensated or attenuated the overall association of stature and refraction.

It is known that the refractive state of the eye is determined by a delicate balance between ocular dimensions and the refracting power of different components, controlled by both passive and active (visual feedback) mechanisms. Studies performed in infants and children have revealed that the eye is capable of achieving emmetropia despite dramatic changes in eyeball size during growth and development.[17] It is, therefore, a possibility that even with variation in eyeball size in relation to individuals' height, the emmetropic refraction can still be maintained.

Conclusion

In this study, we described the normal range of ocular biometric components in a sample population of candidates aspiring to join the armed forces and compared these biometric variables with height. The study revealed a positive correlation between AL and height. Individual height is one of the important parameters in assessing the fitness of candidates, along with axial biometry. We recommend that AL criteria should be correlated with height parameters in candidates with myopia or any refractive surgeries prior to ascertaining the fitness status.

Our study has the limitation of having a smaller sample size of emmetropic candidates. Further studies are required in this field, having a larger sample size and analyzing all the spectrums of refractive errors for the application of existing knowledge.

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