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Ocular biometry and anthropometric measurements in young myopes – A case–control study

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ABSTRACT

Background: The prevalence of myopia in the 5–15-year age group in India has been 7.5% over the past four decades. While ocular growth and physical growth occur simultaneously during early life, the existence of a common regulatory system for both is still debated. **Aims and Objectives:** This study aims to analyze the ocular biometry and anthropometric values of young myopes and emmetropes aged 18–25 years. **Materials and Methods:** This case–control study involved a sample size of 86 participants. Corneal curvature was measured using keratometry, while A-scan ultrasonography was utilized to measure axial length, lens thickness, anterior chamber depth, and vitreous chamber depth. **Results:** The results indicated that there were no significant differences in ocular biometry and anthropometric values between the case and control groups, except for corneal thickness and axial length. The mean corneal thickness was found to be 549.64 µm in the case group and 566.05 µm in the control group, while the mean axial length was 24.70 mm in the case group and 23.41 mm in the control group. An increase in height was correlated with longer axial length in myopes. **Conclusion:** There was no difference in anthropometry and ocular biometry in emmetropes and myopes in the age group of 18–25 years of age. Myopes tend to have thinner corneas, which should be taken into consideration before performing refractive surgeries. The presence of thin corneas in individuals with myopia can result in inaccurately low measurements of intraocular pressure, potentially hampering the early detection of glaucoma within this high-risk demographic.

Key words: Myopia in young; Height; Corneal thickness; Axial length

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INTRODUCTION

Myopia, also known as shortsightedness, occurs when parallel rays from infinity focus in front of the retina when the accommodation is at rest. In certain areas of East and Southeast Asia, myopia has reached almost epidemic levels.[1] Over the past four decades, the crude prevalence of myopia among individuals aged 5–15 years in India has been 7.5%.[2] The main components of refraction include the cornea, crystalline lens, and axial length of the eye. At birth, the eyes are typically hyperopic by about 2D. Ocular growth is most rapid during the first years of life, followed by a slower progression until puberty, after which it stabilizes. However, in myopic eyes, the axial length continues to increase throughout adolescence and early adulthood, disrupting the normal growth pattern of the eye.[3] The process through which a normal eye coordinates the growth of its refractive components to achieve emmetropia (planovision) is called emmetropization.[3] Failure of emmetropization is the main cause of refractive errors (REs). Myopia of this type usually progresses during adolescence and the 20s before stabilizing in the 20s and 30s.[3] Known risk factors for myopia include hereditary factors,[4] excessive near-work activities, increased time spent indoors,[5,6] and intense

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educational pressure.[7] While ocular growth and physical growth occur simultaneously in the early years of life, it is still unclear whether there is a common regulatory system governing both processes. Body stature indicators such as height, weight, and body mass index (BMI) are believed to be associated with refraction, but there is no consensus on this matter so far.[8] It is well documented that myopia is related to an increased axial length,[9] and increased height and weight have also been associated with an increase in axial length.[10]

Aims and objectives

This study aims to measure and analyze the ocular biometry and anthropometric values of young myopes and emmetropes aged 18–25 years.

MATERIALS AND METHODS

The study was conducted in a hospital and used an unmatched case–control design for a period of 2 months. The study included participants who were myopic patients and emmetropic individuals between the ages of 18 and 25. For the inclusion criteria, the cases included individuals between the ages of 18 and 25 with a spherical equivalent of −0.5 D or greater, as diagnosed in the ophthalmology outpatient department (OPD). The controls were also between the ages of 18 and 25, but without any REs as diagnosed in the ophthalmology OPD. The exclusion criteria for both cases and controls included individuals with a history of ocular trauma or refractive surgery, as well as those with ocular pathologies such as uveitis, congenital anomalies, keratoconus, or who had undergone any previous ocular surgery.

Sample size calculation

In an unmatched case–control study with equal allocation, the required sample size in each of the case and control groups is 43. The sampling strategy used was convenient sampling. With hypothesis testing of the odds ratio, probability of exposure given disease absent =0.1, anticipated odds ratio =4.8, probability of exposure given disease present =0.3478, power (%) =80, alpha error (%) =5, and sided =2.

The demographic details of the participants were recorded. Onset and duration of myopia, parental history of myopia, and hours spent in near work and outdoor activities were noted.

Study variables

Height was measured by having the subject stand barefoot on the base of the height meter and recording it in centimeters (cm). Weight was measured without shoes and heavy coats on a calibrated electronic weighing scale and recorded in kilograms (kg). BMI was calculated by dividing weight in kg by the square of height in meters and recorded in kilograms per square meter (kg/m^2). An ocular examination was conducted. Visual acuity was tested using Snellen's chart. The anterior segment was examined using slit-lamp biomicroscopy, and the posterior segment was examined using a +90D lens and indirect ophthalmoscopy. Refraction was determined using retinoscopy. Cycloplegic refraction was not used in this study, as it was conducted in the 18–25-year age group. The spherical equivalent is calculated by adding the sum of the sphere power with half of the cylinder power. Myopia is defined as a spherical equivalent greater than or equal to −0.50 D. Corneal curvature was measured using keratometry. The average of five readings in the flatter and steeper meridians was obtained. Axial length, lens thickness, and anterior chamber depth were measured using A-scan ultrasonography. Before the ultrasound biometry measurements, a drop of 0.5% proparacaine was instilled into each eye for anesthesia. The average of five values was taken, with the standard deviation of the five measurements being <0.12 mm.

Statistical analysis

The data collected were entered into a Microsoft Excel sheet for data collection and statistical analysis. Categorical data were expressed in terms of numbers and percentages. Continuous data were expressed as mean±standard deviation. Ocular biometric measurements were compared between cases and controls using an independent t-test. Mann–Whitney U-test was applied to find an association between anthropometric measurements and the refractive state of the myopes. A correlation between ocular biometry and anthropometry among myopes was found using Pearson's correlation test. $P<0.05$ was considered statistically significant.

The study protocol was performed in accordance with the principles of the Declaration of Helsinki. Written consent was obtained from all participants after explaining the study in their own language.

RESULTS

The mean age of the participants was 21.628 years, with a standard deviation of 1.3097 years (Figure 1). Regarding gender distribution, there were 21 males (48.8%) and 22 females (51.2%) among the participants (Figure 2). In terms of family history, the majority of participants reported no family history of the condition (83.72%), while a smaller proportion reported a positive family history (16.28%). When considering outdoor hours per day, the distribution varied: 2.33% reported no outdoor

Table 1: Ocular biometry details of myopes (n=47) and emmetropes (n=43)

S. No.	Variables	Myopes		Emmetropes		P-value* (Independent t-test)
		Mean	SD (±)	Mean	SD (±)	
1.	Corneal thickness/RE	549.638	30.1016	566.047	38.4899	0.026
2.	Anterior chamber depth/RE	3.6853	0.38785	3.6991	0.35523	0.862
3.	Lens thickness/RE	3.5409	0.23587	3.5665	0.22489	0.599
4.	Axial length/RE	24.7094	0.96342	23.4142	0.70108	0.000

*P<0.05 is considered to be statistically significant, RE: Refractive error

Table 2: Anthropometric details of myopes (n=47) and emmetropes (n=43)

S. No.	Variables	Myopes		Emmetropes		P-value
		Mean	SD (±)	Mean	SD (±)	
1	Height	1.6657	0.10012	1.6491	0.09281	0.416
2	Weight	62.340	13.7434	62.000	10.4266	0.896
3	BMI	22.37	4.00	22.80	3.58	0.591

BMI: Body mass index

Table 3: Correlation between ocular biometry and anthropometry among myopes – Pearson's correlation

Measurements	Corneal thickness/RE	Anterior chamber depth/RE	Lens thickness/RE	Axial length/RE
Height	0.016 (0.879)	−0.013 (0.906)	0.008 (0.937)	0.230 (0.029)
Weight	0.012 (0.911)	0.137 (0.197)	−0.158 (0.138)	0.146 (0.169)
BMI	0.004 (0.972)	0.173 (0.102)	−0.189 (0.074)	0.010 (0.924)

BMI: Body mass index, RE: Refractive error

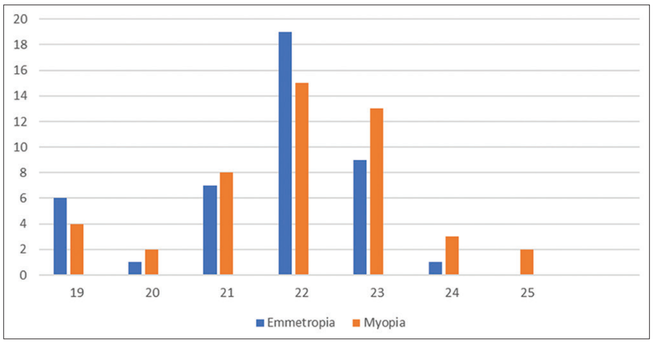

Figure 1: Age distribution in emmetropia and myopia

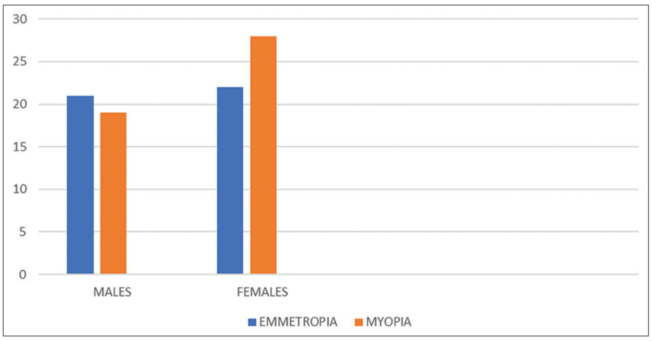

Figure 2: Sex distribution in emmetropia and myopia

hours, 2.33% reported 0.5 h, 4.65% reported 1 h, 32.56% reported 2 h, 23.26% reported 3 h, 25.58% reported 4 h, and 9.30% reported 5 h.

In the myopia group, the mean age of the participants was 22.02 years, with a standard deviation of 1.43 years. The duration of myopia averaged at 7.340 years, with a standard deviation of 2.62 years. On the other hand, the mean duration of spectacle wear was 6.872 years, with a standard deviation of 2.89 years. Participants spent an average of 1.723 h outdoors per day, with a standard deviation of 1.39 h.

The t-test results comparing the mean differences in the ocular axial components of the subjects with myopia and those without myopia showed that the mean axial length in the right eye was high among subjects with myopia compared to emmetropes, and this association was found to be statistically significant (P<0.05). Furthermore, mean corneal thickness in the right eye was less in myopes in comparison with emmetropes, and this association was found to be statistically significant (P<0.05) (Table 1).

The Mann–Whitney test showed that there was no significant association between any of the anthropometric measures (weight, height, and BMI) and the refractive state of the myopes. There was only a significant association between the outdoor hours of the individuals and the refractive state of myopes (P<0.05) (Table 2 and Figures 3 and 4).

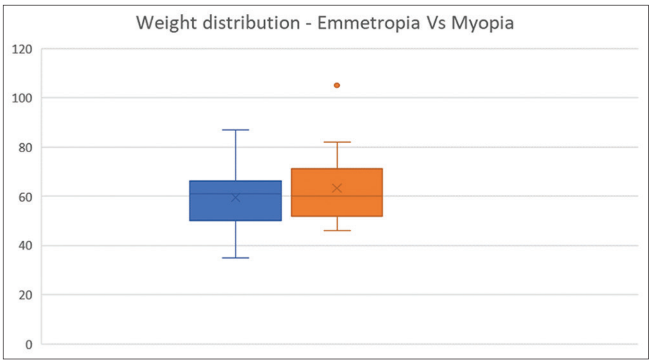

Figure 3: Weight distribution in emmetropia and myopia

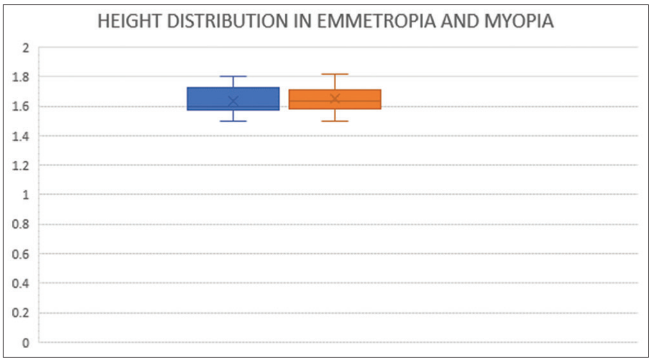

Figure 4: Height distribution in emmetropia and myopia

The correlation between anthropometric and ocular biometric measurements was calculated using Pearson's correlation. Only the height of the myopic patients positively correlates with their axial length of the right eye, and it was found to be statistically significant (P<0.05) (Table 3).

DISCUSSION

In this study, apart from comparing anthropometry and ocular biometry between emmetropic and myopic groups, we explored the overall association between anthropometric measures and ocular biometrics in the age group of 19–26 years.

The comparison of anthropometric measurements (height, weight, and BMI) in emmetropes and myopes was not statistically significant. The mean height was 1.6657 m in myopes, and 1.6491 m in emmetropes and it was not statistically significant (P=0.416). The mean weight was 62.340 kg in myopes and 62.000 kg in emmetropes and was not statistically significant (P=0.896). The BMI comparison was also not statistically significant.

Among the ocular biometry parameters, the corneal thickness (Mean-549.638 microns in myopia, mean-566.047 microns in emmetropes) was thinner in myopes, and the axial length was longer in myopes (mean-Axial length was 24.7094 mm in myopes and 23.414 mm in emmetropes). These differences were statistically significant.

Several population-based studies have examined the correlation between height and myopia, particularly among young adults.[8,11-13] Hang et al., discovered a significant relationship between axial length and height in Chinese twins. Conversely, Sharma et al., reported an inverse association between height and RE, indicating that taller children were more likely to have myopia. In contrast, Rosner et al., conducted a study involving 106,926 Israeli male military recruits aged 17–19 years and found no link between myopia and body stature. These discrepancies could be influenced by ethnic and demographic variations, thus rendering the relationship between myopia and height still ambiguous.

Various hypotheses have been proposed to explain these findings. One hypothesis suggests that the mechanisms of emmetropization, the process by which the eye achieves normal refractive status, may be linked to overall body growth. Taller children with longer eyeballs tend to have deeper vitreous chambers and flatter corneas. Although eyes in taller children maintain similar lens thickness and anterior chamber depths, the elongation of the vitreous chamber causes remodeling of the scleral extracellular matrix, and it appears to be the primary mechanism driving longer eye development in taller individuals.[8,14] Environmental factors, such as increased near work, and systemic physiological changes, such as hormonal fluctuations during puberty and metabolic changes, along with socioeconomic status, may also play significant roles in refractive development.[8,14] These influences can affect ocular development, thereby impacting refractive outcomes more prominently during later childhood years than in early adulthood. Consequently, the relationship between height and myopia may become less clear or even obscured during early adulthood.

The myopic group had a thin central corneal thickness (CCT) in this study. Elijah et al., found out that myopes have a lower CCT compared to emmetropes, and this difference is statistically significant.[15] Zhou et al., proposed that children with thinner CCT in myopia may be associated with a faster speed of myopic progression and AL elongation speed. Thin CCT may be associated with faster myopia progression.[16] Divya et al.,[17] and Kotb and Eissa,[18] found no association between a thin cornea and myopia.

Limitations of the study

The hospital-based study has limitations, including a small sample size. Moreover, the study focuses on adults whose growth has already stopped and whose body stature remains relatively consistent. Conducting the study with growing teenagers could uncover different associations. Since the study only involves adult participants, it may not capture the dynamic changes in ocular development that occur during adolescence. Therefore, it may not accurately reflect the relationship between height and myopia during periods of active growth and development in younger age groups.

CONCLUSION

In the age group of 18–25 years, no significant differences were observed in both anthropometry and ocular biometry between emmetropes and myopes. However, a noteworthy correlation was found between increased height and axial length, indicating the existence of a central regulatory mechanism that governs both phenomena. To gain a deeper understanding of these relationships, more detailed studies are needed, particularly focusing on the developmental years from 8 to 18 years of age, when significant growth and ocular changes take place. Furthermore, individuals with myopes commonly have thinner corneas, which should be carefully considered before considering refractive surgeries. Thin corneas may result in underestimated intraocular pressure measurements, potentially complicating the early detection of glaucoma in this high-risk population.

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REFERENCES

1. Morgan IG, French AN, Ashby RS, Guo X, Ding X, He M, et al. The epidemics of myopia: Aetiology and prevention. Prog Retin Eye Res. 2018;62:134-149.
   https://doi.org/10.1016/j.preteyeres.2017.09.004
2. Agarwal D, Saxena R, Gupta V, Mani K, Dhiman R, Bhardawaj A, et al. Prevalence of myopia in Indian school children: Meta-analysis of last four decades. PLoS One. 2020;15(10):e0240750.
   https://doi.org/10.1371/journal.pone.0240750
3. Daniel M and Albert JW. Albert and Jakobiecs Principle and Practice of Ophthalmology. Vol. 4. United States: Saunders; 2008. p. 4145-4146.
4. Kim MH, Zhao D, Kim W, Lim DH, Song YM, Guallar E, et al. Heritability of myopia and ocular biometrics in Koreans: The healthy twin study. Invest Ophthalmol Vis Sci. 2013;54(5):3644-3649.
   https://doi.org/10.1167/iovs.12-11254
5. Huang HM, Chang DS and Wu PC. The association between near work activities and myopia in children-a systematic review and meta-analysis. PLoS One. 2015;10:e0140419.
   https://doi.org/10.1371/journal.pone.0140419
6. He M, Xiang F, Zeng Y, Mai J, Chen Q, Zhang J, et al. Effect of time spent outdoors at school on the development of myopia among children in China: A randomized clinical trial. JAMA. 2015;314(11):1142.
   https://doi.org/10.1001/jama.2015.10803
7. Williams KM, Bertelsen G, Cumberland P, Wolfram C, Verhoeven VJ, Anastasopoulos E, et al. Increasing prevalence of myopia in Europe and the impact of education. Ophthalmology. 2015;122(7):1489-1497.
   https://doi.org/10.1016/j.ophtha.2015.03.018
8. Lee DC, Lee SY and Kim YC. An epidemiological study of the risk factors associated with myopia in young adult men in Korea. Sci Rep. 2018;8:511.
   https://doi.org/10.1038/s41598-017-18926-2
9. Morgan IG, Ohno-Matsui K and Saw SM. Myopia. Lancet. 2012;379(9827):1739-1748.
   https://doi.org/10.1016/S0140-6736(12)60272-4
10. Ye S, Liu S, Li W, Wang Q, Xi W and Zhang X. Associations between anthropometric indicators and both refraction and ocular biometrics in a cross-sectional study of Chinese school children. BMJ Open. 2019;9(5):e027212.
    https://doi.org/10.1136/bmjopen-2018-027212
11. Zhang J, Hur YM, Huang W, Ding X, Feng K and He M. Shared genetic determinants of axial length and height in children: The Guangzhou twin eye study. Arch Ophthalmol. 2011;129:63-68.
    https://doi.org/10.1001/archophthalmol.2010.323
12. Sharma A, Congdon N, Gao Y, Lu Y, Ye Y, Wu J, et al. Height, stunting, and refractive error among rural Chinese schoolchildren: The See Well to Learn Well project. Am J Ophthalmol. 2010;149:347-353.e1.
    https://doi.org/10.1016/j.ajo.2009.08.015
13. Rosner M, Laor A and Belkin M. Myopia and stature: Findings in a population of 106,926 males. Eur J Ophthalmol. 1995;5(1):1-6.
    https://doi.org/10.1177/112067219500500101
14. Saw SM, Chua WH, Hong CY, Wu HM, Chia KS, Stone RA, et al. Height and its relationship to refraction and biometry parameters in Singapore Chinese children. Invest Ophthalmol Vis Sci. 2002;43(5):1408-1413.
15. Elijah CN, Pedro EC and Ejimadu CS. Association between myopia and central corneal thickness among patients in a tertiary hospital in south-south Nigeria. Adv Ophthalmol Vis Syst. 2016;5(2):221-223.
    https://doi.org/10.15406/aovs.2016.05.00147
16. Zhou P, Wang DD, Fan L, Yang L and Zhao MW. Thin central corneal thickness may be a risk factor for myopia progression in children. J Ophthalmol. 2023;2023:3815863.
    https://doi.org/10.1155/2023/3815863
17. Divya K, Ganesh MR and Sundar D. Relationship between myopia and central corneal thickness - A hospital based study from South India. Kerala J Ophthalmol. 2020;32:45-50.
    https://doi.org/10.4103/kjo.kjo_95_19
18. Kotb M and Eissa SA. correlation between myopic refractive error, corneal power and central corneal thickness in the Egyptian population. Clin Ophthalmol. 2021;15:1557-1566.
    https://doi.org/10.2147/OPTH.S304693

Authors' Contributions:
UBZ- Definition of intellectual content, literature survey, Prepared first draft of manuscript, implementation of study protocol, data collection, data analysis, manuscript preparation, and submission of article; **MNY-** Concept, design, clinical protocol, manuscript preparation, editing, and manuscript revision;
SDH- Design of study, statistical analysis, and interpretation; **HR-** Review manuscript; **RB-** Review manuscript; **NN-** Literature survey and preparation of figures;
AS- Coordination and manuscript revision.

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