e-ISSN: 0975-1556, p-ISSN:2820-2643

Available online on www.ijpcr.com

International Journal of Pharmaceutical and Clinical Research 2024; 16(6); 1011-1016

Original Research Article

Refractory Error and Ocular Biometry among Young Adults in Muzaffarpur, Bihar

Sweta Kumari[1], Sushma Kumari[2], Rajiv Kumar Singh[3]

[1]Senior Resident, Department of Ophthalmology, Sri Krishna Medical College & Hospital, Muzaffarpur, Bihar, India.

[2]Senior Resident, Department of Ophthalmology, Sri Krishna Medical College & Hospital, Muzaffarpur, Bihar, India.

[3]Professor & Head, Department of Ophthalmology, Sri Krishna Medical College & Hospital, Muzaffarpur, Bihar, India.

Received: 25-03-2024 / Revised: 23-04-2024 / Accepted: 25-05-2024

Corresponding Author: Dr. Sweta Kumari

Conflict of interest: Nil

Abstract:

Objectives: Refractive error is related to anatomic and functional differences in the eye, particularly in axial length, lens thickness, and lens opalescence. Myopia progression is more commonly produced by the increase of AL than for changes in the other optical components. In fact, the measurement of AL has been considered the most accurate way to monitor myopia progression. The present study was to evaluate the refractory error and ocular biometry among young adults in Muzaffarpur, Bihar.

Methods: An ophthalmological examination was conducted with the assessment of visual acuity, the measurement of static refraction with the use of an autorefractor under cycloplegia, with prior administration of 0.5% proparacaine, followed by one application of 1% cyclopentolate eye drops, and two applications of 1% tropicamide, one drop each, with 5-minute intervals between drops. Biomicroscopic examination of the anterior segment was performed using a slit lamp, tonometry, cover test, corneal topography, and optical biometry.

Results: A total of 100 adults with age group 18-30 years were enrolled. The mean age was 22.56±3.23 years. 42(42%) participants were males and 58(58%) were females. Regarding refractive errors, 12(12%) were hyperopic, 32(32%) were emmetropic, 51(51%) were myopic and 5(5%) were high myopic. most of the patients of18(18%) emmetropia had no family history. Most of the patients of 25(25%) myopia had history of one parent. 5(5%) patients of myopia had both parent history. 5% patients had not known the causes of refractory error. Most of the 34(34%) patients had >0 D Spherical equivalent OD. 31(31%) patients had -2.50 to 0 D. 28(28%) patients had -5.50 to -2.50 spherical equivalent OD.

Conclusions: Myopia is the most common refractory error in young adult. Anterior segment biometric components and axial length make the greatest contribution to spherical equivalent in hyperopia and high myopia.

Keywords: Refractory Error, Ocular Biometry, Young Adult.

Introduction

Refractive error is related to anatomic and functional differences in the eye, particularly in axial length, lens thickness, and lens opalescence [1,2].

Refractive error has a significant financial and practical impact on populations worldwide, and has potential to increase the risk of ocular disease, for example retinal detachment in myopic eyes and acute glaucoma in hyperopic eyes [3].

Myopia routinely develops in schoolchildren but may also appear in young people or adults [4]. The earlier myopia onsets, the greater will be the final myopic power expected in adulthood [5, 6]. Myopia progression is more commonly produced by the increase of AL than for changes in the other optical components [7, 8]. In fact, the measurement of AL has been considered the most accurate way to monitor myopia progression [9].

In India, the prevalence of myopia among school children has shown a steady increase in the past decade from 4-8% to 14-21% [10, 11]. Accelerated eye growth is one of the key factors in the onset and progression of myopia. Hence, it is important to study the distribution of ocular biometry parameters among children to understand and predict myopia [12,13]. It is also important to have baseline ocular biometry data for individual ethnicity and race to understand the regional prevalence and patterns of myopia and to be able to correlate and compare with other regions and ethnicities [14].

Patients with high myopia, and consequently, AL ≥ 26 mm, have higher risks of decreased visual acuity in adulthood due to myopic maculopathy, retinal detachment and glaucoma [15, 16]. Although the growth of AL in the population from childhood to young age has been well studied, just a few studies have been reported in young adulthood [6, 7, 17]. Late adolescents are understood as the population between 17 and 19 years old, and young adults, between 20 and 24 years old, according to the World Health Organization [18]. Objectives of our study was to evaluate the refractory error and ocular biometry among young adults in Muzaffarpur, Bihar.

Material & Methods

The present study was conducted in the Department of Ophthalmology, Sri Krishna Medical College & Hospital, Muzaffarpur, Bihar during a period from July 2023 to October 2023. Data was collected with irrespective of sex by using the random sampling methods

Inclusion Criteria:

The selected subjects answered a questionnaire about outdoor activities, the history of their myopia onset, and parents' refractive history. All the participants with corrected visual acuity ≥ 0.66 in both eyes and with a normal ophthalmologic examination, were included.

Exclusion Criteria:

Participants with associated ocular pathologies, with incomplete data, those who did not answer the questionnaire, those with astigmatism ≥ 2 D or topographic irregular astigmatism, allergic to any cycloplegic drug, patients with syndromes that interfere with the eye were excluded.

Methods:

A total of 100 young adults with age group 18 to 30 years were selected for the study. Subjects were evaluated at the ophthalmology OPD, SKMCH, Muzaffarpur, Bihar.

An ophthalmological examination was conducted with the assessment of visual acuity, the measurement of static refraction with the use of an autorefractor under cycloplegia, with prior administration of 0.5% proparacaine, followed by one application of 1% cyclopentolate eye drops, and two applications of 1% tropicamide, one drop each, with 5-minute intervals between drops. Biomicroscopic examination of the anterior segment was performed using a slit lamp, tonometry, cover test, corneal topography, and optical biometry. Lens power was measured indirectly with Bennett and Rozema's formula using the cycloplegic refraction, K1, K2, anterior chamber depth, lens thickness and AL [19].

Statistical Analysis

Data was analysed by using latest version of SPSS software. Mean and standard deviation were observed. P- value was taken less than or equal to 0.05 ($p \leq 0.05$) for significant differences.

Results

In the present study, a total of 100 adults with age group 18-30 years were enrolled. The mean age was 22.56±3.23 years. 42(42%) participants were males and 58(58%) were females. Regarding refractive errors, 12(12%) were hyperopic, 32(32%) were emmetropic, 51(51%) were myopic and 5(5%) were high myopic. Mean of refractory error and ocular biometry was seen in table 1.

Table 1: Mean refractive and biometric data (±S.D.) for right eyes of all subjects.

Variables	Mean ± S.D.
Age	22.56±3.23
Uncorrected visual acuity OD	0.42±0.35
Uncorrected visual acuity OS	0.66±0.31
Spherical equivalent OD	-1.83±2.56
Spherical equivalent OS	-1.89±2.83
Keratometry - K1	44.21±2.76
Keratometry - K2	45.72±2.12
Anterior chamber depth	4.21±0.31
Lens thickness	5.22±0.32
Axial length	26.75±2.72
Axial length emmetropic	24.68±0.92
Axial length myopic	26.74±1.24
Axial length high myopic	28.12±3.78
Axial length hyperopic	24.86±0.74
Lens power	24.12±2.10

In the present study, most of the patients of18(18%) emmetropia had no family history. Most of the patients of 25(25%) myopia had history of one parent. Most of the 5(5%) patients of myopia had both parent history. 5% patients had not known the causes of refractory error.

Table 2: Distribution of spherical equivalent refraction for right eyes of all subjects.

Refractive group	No Family history	One parent	Both parent	Don't know	Total
Hyperopia	6(6%)	4(4%)	2(2%)	-	12(12%)
Emmetropia	18(18%)	7(7%)	4(4%)	3(3%)	32(32%)
Myopia	19(19%)	25(25%)	5(5%)	2(2%)	51(51%)
High myopia	1(1%)	3(3%)	1(1%)	-	5(5%)
Total	45(45%)	41(41%)	12(12%)	5(5%)	100(100%)

In the present study, most of the 34(34%) patients had >0 D Spherical equivalent OD. 31(31%) patients had -2.50 to 0 D. 28(28%) patients had -5.50 to -2.50 spherical equivalent OD.

Table 3: Distribution of refractive errors.

Spherical equivalent OD	Percentage
-10 to -7.50	1(1%)
-7.50 to -5.50	6(6%)
-5.50 to -2.50	28(28%)
-2.50 to 0	31(31%)
>0	34(34%)
Total	100(100%)

Discussions

Refractive error has a significant financial and practical impact on populations worldwide, and has potential to increase the risk of ocular disease, for example retinal detachment in myopic eyes and acute glaucoma in hyperopic eyes [3]. In some studies, part of refractive errors has been attributed to ocular biometrics [20,21]. Most reports suggest axial length (AL) and vitreous chamber depth (VCD), as the most important components in relation to refractive errors [22,23]. Studies on the association between refractive errors and ocular biometrics such as corneal power (CP), central corneal thickness (CCT), anterior chamber depth (ACD), and lens thickness (LT) are inconclusive. For example, Shufelt et al [24] and Mallen et al[21] reported a correlation between refractive errors and CP while McBrien et al [25] and Yekta et al [26] found no significant correlation between these two variables. Some studies have reported higher ACD readings in myopes and lower readings in hyperopes [21,27].

In the present study,100 adults with age group 18-30 years were participated. The mean age was 22.56±3.23 years. 42(42%) participants were males and 58(58%) were females. Regarding refractive errors, 12(12%) were hyperopic, 32(32%) were emmetropic, 51(51%) were myopic and 5(5%) were high myopic.

A study in 2002 from the Brazilian northeast population, considering the age group 16 years or more, found a myopia prevalence of 15.81% [28]. It is important to consider that the cut point for myopia was based on spherical power and not on spherical equivalent.

In the present study, most of the patients of 18(18%) emmetropia had no family history. 25(25%) myopia had history of one parent. 5(5%) patients of myopia had both parent history. 5% patients had not known the causes of refractory error. Mean axial length (AL) was 26.75±2.72 mm. The standard value of AL of the human eye is internationally taken to be around 24 mm in adulthood regardless of sex or race, whereas AL tends to be longer in myopic and shorter in hypermetropic eyes comparing to that of emmetropic [29]. AL average values are variables in the literature. The mean AL observed in this paper is larger than those of Refs. [30, 31]. In which ultrasound, low-coherence reflectometry, and partial coherence interferometry are used, respectively. Conversely, Refs. [32, 33] using low-coherence reflectometry and partial coherence interferometry, respectively, show larger average values. Previous researches in Cuba report larger [34], much larger [36], shorter [35], and much shorter [36] average AL when compared with our results. It should be noted that the analyzed periods in all these works include only one year or less, and that the sample size is much smaller than ours, explaining the dispersion in their results. Specifically, in the case of Ref. [37], more than 93% of patients had myopic astigmatism while the result of Ref. [36] is in accordance with his study´s design, where all the patients were hyperopes. Average ACD in our work (4.21±0.31) is shallower than reported in Latino populations [38] and to a lesser extent, those of Refs. [39, 40] in Asian populations. On the other hand, Hashemi et al. [31] report an ACD average even shallower than ours using the biometer LENSTAR/BioGraph (WaveLight AG, Erlangen, Germany). Differences between these two biometers may affect the comparative analysis since ACD value in Lenstar refers to the distance between corneal endothelium and lens anterior capsule while the distance for this variable in IOL Master is taken from corneal epithelium to lens anterior capsule. That is why Lenstar uses the sum of central pachymetry and ACD values for IOL calculation [35].

In the present study, mean lens thickness (LT) was 5.22±0.32 mm. It was higher than that reported in studies that used an A-scan ultrasound, which has lower resolution than the SS-OCT, for studying Latino [38, 41] and elderly Chinese populations [42]. Hashemi et al. [31] and Ferreira et al. [32], using both low-coherence optical reflectometry (Lenstar) observed much smaller LT values. As far as we know, a previous report of this magnitude has not been published on Cuban patients. Keratometry average value and its distribution in our study are close to those observed in European population based studies using partial-coherence interferometry [43] and optical low-coherence reflectometry [32].

Cuban researchers [37, 45] using autorefractor–keratometers have previously reported slightly lower values. Keratometry measurements may vary when different evaluation methods are used, as it was demonstrated in Ref. [46] reporting a significantly lower corneal power when measurements were obtained with autorefractor–keratometers than those measured by IOL Master.

In the present study, most of the 34(34%) patients had >0 D Spherical equivalent OD. 31(31%) patients had -2.50 to 0 D. 28(28%) patients had -5.50 to -2.50 spherical equivalent OD. The World Health Organization – WHO - defines high myopia as <-5 D, however, currently, the International Myopia Institute - IMI – considers it to be <-6 D [47, 48].

In terms of biometric measurements, the two previously published population-based studies have found contradictory age-related differences [49, 2]. In Singapore, younger adult Chinese had longer axial lengths compared to older Chinese.10In contrast, in Mongolia, there was no age-related difference in axial length.11 Similar to the Mongolians, in our study, no age-related differences in axial length were noted. One explanation for this is that once the eye has achieved its adult size, little change occurs in the axial length during adulthood and with aging.

Conclusions

The present study concluded that the myopia is the most common refractory error in young adult. Anterior segment biometric components and axial length make the greatest contribution to spherical equivalent in hyperopia and high myopia.

References

1. Leighton DA, Tomlinson A. Changes in axial length and other dimensions of the eyeball with increasing age. Acta Ophthalmol (Copenh). 1972; 50:815– 826.
2. Wickremasinghe S, Foster PJ, Uranchimeg D, et al. Ocular biometry and refraction in Mongolian adults. Invest Ophthalmol Vis Sci. 2004; 45:776 –783.
3. Edward A. H. Mallen, Yazan Gammoh, Muawyah Al-Bdour, Fouad N. Sayegh. Refractive error and ocular biometry in Jordanian adults. Ophthal. Physiol. Opt. 2005; 25: 302–3 09.
4. Kara-José N, Holzchuh N, Temporini ER. Vícios de refração em escolares da cidade de São Paulo, Brasil. Bol Oficina Sanit Panam 1984; 96(4): 326-33.
5. Chua SYL, Sabanayagam C, Cheung YB, et al. Age of onset of myopia predicts risk of high myopia in later childhood in myopic Singapore children. Ophthalmic Physiol Opt 2016; 36(4): 388-94.
6. Tideman JWL, Polling JR, Jaddoe VWV, Vingerling JR, Klaver CCW. Environmental risk factors can reduce axial length elongation and myopia incidence in 6- to 9-year-old children. Ophthalmology 2019; 126(1): 127-36.
7. Larsen JS. The sagittal growth of the eye. IV. Ultrasonic measurement of the axial length of the eye from birth to puberty. Acta Ophthalmol 1971; 49(6): 873-86.
8. Fledelius HC, Christensen AS, Fledelius C. Juvenile eye growth, when completed? An evaluation based on IOL-Master axial length data, cross-sectional and longitudinal. Acta Ophthalmol 2014; 92(3): 259-64.
9. Galán MM, Tideman JWL, Iribarren R. The role of axial length and keratometry in the follow-up of myopic children. Oftalmol Clin Exp 2021; 14(2): 65-70.
10. Dandona R, Dandona L, Srinivas M, et al. Refractive error in children in a rural population in India. Invest Ophthal Vis Sci 2002; 43:615-22.
11. Kalikivayi V, Naduvilath TJ, Bansal AK, Dandona L. Visual impairment in school children in Southern India. Indian J Ophthalmol. 1997; 45:129.
12. Flitcroft D. Emmetropisation and the aetiology of refractive errors. Eye 2014; 28:169.
13. Mutti DO, Hayes JR, Mitchell GL, et al. Refractive error, axial length, and relative peripheral refractive error before and after the onset of myopia. Invest Ophthal Vis Sci 2007; 48:2 510-9.
14. Gopalakrishnan A, Hussaindeen JR, Chaudhary R, Ramakrishnan B, Arunachalam S, Balakrishnan AC, J S SD, Sahoo M, S R, M V, S S, Narayanan A. Results of the School

Children Ocular Biometry and Refractive Error Study in South India. Turk J Ophthalmol 2022; 52:412-420.

15. Neelam K, Cheung CMG, Ohno-Matsui K, Lai TYY, Wong TY. Choroidal neovascularization in pathological myopia. Prog Retin Eye Res 20 12; 31(5): 495-525.
16. Grossniklaus H, Green WR. Pathologic findings in pathologic myopia. Retina 1992; 12(2): 127-33.
17. Zadnik K, Mutti DO, Mitchell GL, Jones LA, Burr D, Moeschberger ML. Normal eye growth in emmetropic schoolchildren. Optom Vis Sci 2004; 81(11): 819-28.
18. WHO, World Health Organization. Young People's Health - a challenge for society. Report of a WHO study group on young people and health for all. Technical Report Series 19 86: 731.
19. Rozema JJ, Atchison DA, Tassignon MJ. Comparing methods to estimate the human lens power. Invest Ophthalmol Vis Sci 2011; 52(11): 7937-42.
20. Warrier S, Wu HM, Newland HS, Muecke J, Selva D, Aung T, et al. Ocular biometry and determinants of refractive error in rural Myanmar: The Meiktila Eye Study. Br J Ophthalmol 2008; 92:1591-1594.
21. Mallen EA, Gammoh Y, Al-Bdour M, Sayegh FN. Refractive error and ocular biometry in Jordanian adults. Ophthalmic Physiol Opt 2005; 25:302-309.
22. Garner LF, Stewart AW, Kinnear RF, Frith MJ. The Nepal longitudinal study: Predicting myopia from the rate of increase in vitreous chamber depth. Optom Vis Sci 2004;81: 44-48.
23. Jiang BC, Woessner WM. Vitreous chamber elongation is responsible for myopia development in a young adult. Optom Vis Sci 1996;73: 231-234.
24. Shufelt C, Fraser-Bell S, Ying-Lai M, Torres M, Varma R; Los Angeles Latino Eye Study Group. Refractive error, ocular biometry, and lens opalescence in an adult population: The Los Angeles Latino Eye Study. Invest Ophthalmol Vis Sci 2005;46: 4450-4460.
25. Mc Brien NA, Adams DW. A longitudinal investigation of adult-onset and adult-progression of myopia in an occupational group. Refractive and biometric findings. Invest Ophthalmol Vis Sci 1997;38: 321-333.
26. Yekta AA, Fotouhi A, Hashemi H, Moghaddam HO, Heravian J, Heydarian S, et al. Relationship between refractive errors and ocular biometry components in carpet weavers. Iran J Ophthalmol 2010; 22:45-54.
27. Ojaimi E, Rose KA, Morgan IG, Smith W, Martin FJ, Kifley A, et al. Distribution of ocular biometric parameters and refraction in a population-based study of Australian children. Invest Ophthalmol Vis Sci 2005;46: 2748-2754.
28. Garcia CAA, Oréfice F, Nobre GFD, Souza DB, Rocha MLR, Vianna RNG. Prevalence of refractive errors in students in Northeastern Brazil. Arq Bras Oftalmol 2005; 68(3): 321-5.
29. A. Roy, "Variation of axial ocular dimensions with age, sex, height, BMI -and their relation to refractive status," Journal of Clinical and Diagnostic Research 2015; 9(1): AC01–AC04.
30. L. Curbelo Cunill, J. Hernandez Silva, E. Machado Fern ´ andez ´ et al., "Frecuencia de ametrop´ıas," Frecuencia de Ametrop´ıas, 2005; 18: 1.
31. H. Hashemi, M. Khabazkhoob, M. Miraftab et al., The distribution of axial length, anterior chamber depth, lens thickness, and vitreous chamber depth in an adult population of Shahroud, Iran," BMC Ophthalmology 2012; 12(1): 50.
32. T. B. Ferreira, K. J. Hoffer, F. Ribeiro, P. Ribeiro, and J. G. O'Neill, "Ocular biometric measurements in cataract surgery candidates in Portugal, PLoS One 2017; 12: 10.
33. K. E. Lee, B. E. K. Klein, R. Klein, Z. Quandt, and T. Y. Wong, "Association of age, stature, and education with ocular dimensions in an older white population," Archives of Ophthalmology, 2009; 127(1) : 88–93.
34. E. Montero Diaz, M. Serpa Valdes, Y. Cuan Aguilar, P ´ erez ´ Candelaria E de la C, I. Hern´andez L´opez, and M. Vidal del Castillo, "Efectividad de la biometr´ıa de inmersion para el ´ calculo del poder di ´ optrico de la lente intraocular," Revista Cubana de Oftalmolog´ıa, 2014; 27(3): 350–358.
35. I. Miranda Hern´andez, J. R. Hern´andez Silva, M. Rio Torres, Y. Ruiz Rodr´ıguez, J. Del Amo Freire, and A. Bisnubia Vargas, "Evaluacion del equipo de interferometria ´ optica de coher- ´ encia parcial Lenstar en la biometr´ıa ocular," Revista Cubana de Oftalmolog´ıa, 20 10; 23: 665–677.
36. E. Rojas Alvarez, I. Miranda Hern´andez, Y. Ruiz Rodr´ıguez, and J. Gonzalez Sotero, "Extracci ´ on de cristalino transparente ´ en pacientes hipermetropes," ´ Revista Cubana de Oftalmolog´ıa, 2011; 24(1): 40–45.
37. J. A. Fernandez Soler, R. del C. Garc ´ ´ıa Perez, O. M. Mariño ´ Hidalgo, and J. A. Cobas Gonzalez, "Caracterizaci ´ on de las ´ ametrop´ıas atendidas en Consulta de Cirug´ıa Refractiva del Centro Oftalmologico de Holgu ´ ´ın," Correo Cient´ıfico M´edico, 2015; 19(2): 233–245.
38. C. Shufelt, S. Fraser-Bell, M. Ying-Lai, M. Torres, and R. Varma, "Refractive error, ocular biometry, and lens opalescence in an adult

population: the Los Angeles Latino Eye Study," Investigative Opthalmology & Visual Science, 2005; 46,(12): 4450–4460.
39. J. G. Yu, J. Zhong, Z. M. Mei, F. Zhao, N. Tao, and Y. Xiang, "Evaluation of biometry and corneal astigmatism in cataract surgery patients from Central China," BMC Ophthalmology, 2017; 17(1): 56.
40. C.-W. Pan, T.-Y. Wong, L. Chang et al., "Ocular biometry in an Urban Indian population: the Singapore Indian Eye study (SINDI)," Investigative Opthalmology & Visual Science, 2011; 52(9): 6636–6642.
41. M. S. Barlatey, W. Koga-Nakamura, V. Moreno-Londoño, M. Takane-Imay, and C. Gonzalez-Gonz ´ alez, "Distribution of ´ axial length and related factors in an adult population of Mexico City," Revista Mexicana de Oftalmolog´ıa, 2019; 93(5): 233–237.
42. M. He, W. Huang, Y. Li, Y. Zheng, Q. Yin, and P. J. Foster, "Refractive error and biometry in older Chinese adults: the Liwan eye study," Investigative Opthalmology & Visual Science, 2009; 50(11): 5130–5136.
43. N. E. Knox Cartwright, R. L. Johnston, P. D. Jaycock, D. M. Tole, and J. M. Sparrow, Cataract National Dataset electronic multicentre audit of 55 567 operations: when should IOLMaster biometric measurements be rechecked? Eye, 2010; 24(5): 894–900.
44. J. A. Fernandez Soler, R. del C. Garc ´ ´ıa Perez, O. M. Mariño ´ Hidalgo, and J. A. Cobas Gonzalez, "Caracterizaci ´ on de las ´ ametrop´ıas atendidas en Consulta de Cirug´ıa Refractiva del Centro Oftalmologico de Holgu ´ ´ın," Correo Cient´ıfico M´edico, 2015; 19 (2): 233–245.
45. Y. E. Garc´ıa, V. T. Torriente, Z. M. Legon, and I. T. Casado, ´ "Calculo del poder de la lente intraocular mediante biometr ´ ´ıa ultras´onica," Revista Cubana de Oftalmolog´ıa, 2013; 26(3): 399–409.
46. M. Garza-Leon, P. de la Parra-Col ´ ´ın, and T. BarrientosGutierrez, " Estudio comparativo de la medicion del poder ´ corneal central usando el querat´ometro manual, el IOLMaster y el tomografo Sirius," ´ Revista Mexicana de Oftalmolog´ıa, 2016; 90(3): 111–117.
47. World Health Organization - Brien Holden Vision Institute. The impact of myopia. In: The Impact of Myopia and High Myopia Report of the Joint World Health Organization. Brien Holden Vision Institute Global Scientific Meeting on Myopia 2016; 1-29.
48. Flitcroft DI, He M, Jonas JB, et al. IMI – defining and classifying myopia: A proposed set of standards for clinical and epidemiologic studies. Invest Ophthalmol Vis Sci 2019; 60(3) : M20-30.
49. Wong TY, Foster PJ, Ng TP, Tielsch JM, Johnson GJ, Seah SK. Variations in ocular biometry in an adult Chinese population in Singapore: the Tanjong Pagar Survey. Invest Ophthalmol Vis Sci. 2001; 42:73– 80