Arquivos Brasileiros de
Oftalmologia

ORIGINAL ARTICLE

Association between axial length and level of education in elderly patients with cataracts unexposed to electronic devices in the first two decades of life

Associação entre diâmetro axial e nível educacional em pacientes idosos com catarata não expostos a dispositivos eletrônicos nas duas primeiras décadas de vida

Roberto dos Reis[1], Rodrigo Pessoa Cavalcanti Lira[1,2], Mathias Violante Mélega[1], Gabriel Guerra Cordeiro[2], Mauricio Abujamra Nascimento[1], Mônica Alves[1], Carlos Eduardo Leite Arieta[1]

1. Ophthalmology Department, Faculdade de Ciências Médicas, Universidade Estadual de Campinas, Campinas, SP, Brazil.
2. Ophthalmology Department, Center of Medical Sciences, Universidade Federal de Pernambuco, Recife, PE, Brazil.

RESUMO | Objetivo: Determinar se o diâmetro axial está associado ao nível educacional em pacientes idosos com catarata que não foram expostos a dispositivos eletrônicos nas duas primeiras décadas de vida. **Métodos:** Este estudo transversal foi conduzido em pacientes idosos com catarata na cidade de Campinas, Brasil. Os Pacientes foram divididos em 2 grupos: no Grupo 1 foram incluídos aqueles que completaram, pelo menos, o ensino fundamental (incluindo analfabetos e aqueles com ensino fundamental completo ou incompleto), o que corresponde a 12 anos de escolaridade; no Grupo 2 foram incluídos indivíduos que, pelo menos, estudaram até o ensino médio (incluindo indivíduos com ensino médio completo e superior completo ou superior incompleto). A amostra foi selecionada aleatoriamente com estratificação por sexo e idade. O desfecho principal foi a medida do diâmetro axial. **Resultados:** A amostra foi constituída por 472 indivíduos que foram submetidos a cirurgia de catarata. Duzentos e trinta e seis indivíduos (50%) foram alocados no Grupo 1 e duzentos e trinta e seis indivíduos (50%) no Grupo 2. A mediana da idade (IIQ; intervalo) foi 66 (12; 50-89) anos. Duzentos e setenta e dois (57,6%) eram homens e duzentos (42,4%) mulheres, com distribuição simétrica entre os dois grupos. A mediana do diâmetro axial (IIQ; intervalo) foi 22,82 (1,51; 20,34-28,71) mm no Grupo 1 e 23,32 (1,45; 20,51-31,34) mm no Grupo 2 (p<0,001). **Conclusão:** Maiores medidas de diâmetro axial foram associadas a níveis educacionais mais elevados em pacientes idosos submetidos a cirurgia de catarata. Tal achado sugere que a miopização relacionada ao aumento de atividades que utilizam a visão de perto é fenômeno que ocorre antes mesmo da exposição a dispositivos eletrônicos.

Descritores: Comprimento axial do olho; Miopia; Biometria; Catarata; Nível de escolaridade; Humanos; Idoso

ABSTRACT | Purpose: To determine whether the axial length is associated with the education level in elderly patients with cataracts who were not exposed to electronic devices in the first two decades of life. **Methods:** This cross-sectional study was conducted in elderly patients with cataracts in Campinas, Brazil. Patients were divided into 2 groups: Group 1 included those who completed, at most, elementary school (including the illiterate and those who partially or totally attended elementary school), which corresponded to 12 years of schooling; Group 2 included, at least, high school graduates (including those who completed high school and those who partially or fully attended university). The sample was selected randomly with stratification for sex and age. The main outcome was the axial length. **Results:** The sample consisted of 472 elderly patients (236 per group) who underwent cataract surgery. There were 272 (57.6%) men and 200 (42.4%) women; the distribution was symmetrical between the two groups. The median age (IQR; range) was 66 (12; 50-89) years. The median axial length (IQR; range) was 22.82 (1.51; 20.34-28.71) mm in Group 1 and 23.32 (1.45; 20.51-31.34) mm in Group 2 (p<0.001). **Conclusion:** A greater axial length was associated with a higher level of education in elderly patients with cataracts, suggesting that myopization is related to an increase in activities requiring near-vision even before exposure to electronic devices.

Keywords: Axial length, eye; Myopia; Biometry; Cataract; Educational status; Humans; Aged

Submitted for publication: June 18, 2021
Accepted for publication: February 8, 2022

Funding: This study received no specific financial support.

Disclosure of potential conflicts of interest: None of the authors have any potential conflicts of interest to disclose.

Corresponding author: Roberto dos Reis.
E-mail: robdsreis@gmail.com

Approved by the following research ethics committee: UNICAMP (CAAE: 4521502.7.1001.5404).

This content is licensed under a Creative Commons Attributions 4.0 International License.

INTRODUCTION

The axial length (AL) is an important anatomical parameter in ophthalmology and a variable for refractive errors[1]. According to previous studies, the AL is strongly correlated with the state of refraction[2,3]; for each additional 0.1 mm in AL, the eye becomes approximately 0.3 diopters more myopic.

Both the AL and incidence of myopia have been gradually increasing in recent decades[4]. Subjects with a higher level of education, those with occupations requiring near-vision (such as reading, writing, computer using, and video games), and those with a higher income are more likely to have a longer AL and more myopic refractions[2,5]. The AL drastically changes during the first 20 years of life; the eye grows from 16.5 mm at birth to about 23.75 mm in young adults. As the AL remains constant in adults[6-8], the educational level in the first two decades of life may influence the development of myopia in adulthood.

Currently, there are no available data regarding the relationship between AL and education level in Brazil that utilized optical biometry. This study evaluated the influence of educational level on the AL of elderly patients with cataracts who were not exposed to electronic devices in the first two decades of life.

METHODS

Patients

This cross-sectional study was conducted on elderly patients with cataracts between 2016 and 2019 at the State University of Campinas (UNICAMP) in Campinas, Brazil.

The inclusion criteria were as follows: individuals over 49 years old with cataracts who were not exposed to electronic devices (i.e., smartphones, computer screens, tablets, video games) during the first two decades of life. The exclusion criteria were the following: patients who were unable to follow instructions for examinations, presence of corneal pathologies, presence of retinal pathologies that interfered with biometrics (e.g., previous retinal detachment), and patients with an abnormal eye shape (e.g., scleral staphyloma).

Patients were divided into 2 groups according to their level of education: Group 1 included those who completed, at most, elementary school (including the illiterate and those who partially or totally attended elementary school) which corresponded to 12 years of schooling; and Group 2 included, at least, high school graduates (including those who completed high school and those who partially or fully attended university). The sample was selected randomly with stratification for sex and age.

Procedures

During the preoperative exam, the AL of the patients was measured using optical biometrics (LenStar® LS900, Haag-Streit Diagnostics, Switzerland). Measurements were performed by a biometer in standard automatic mode. The subjects were then asked to blink before each scan to be acquired. If it was not possible to determine any parameter in the first capture, a second capture was performed.

No further attempts were made. Medical records and preoperative exam data were collected from each patient. Preoperative refractive error was not considered because it was not reliable due to the presence of nuclear or cortical lens changes alone or in combination with posterior subcapsular opacities.

The main outcome was to compare the AL between the two educational level groups.

Statistical analysis

A sample size of at least 200 patients per group was determined, assuming that the study would have a power greater than 90% and a probability of type 1 error less than 0.05% (two-tailed) to detect a difference of 0.5 mm in the AL (with standard deviation of 1.5 mm and allocation radius of 1) between the two groups.

The data were summarized using descriptive statistics. The Kolmogorov-Smirnov normality test was used to assess the distribution of continuous data. Medians and interquartile ranges (IQR) were used for data with non-normal distribution. The differences in continuous variables between the two groups were compared using the Mann-Whitney U test, whereas those in categorical variables were compared with the Chi-square test. Analyses were performed by SPSS version 21 (IBM Corporation, Armonk, NY, USA). The p values were two-tailed, and statistical significance was set at 0.05.

Ethics statement

All study procedures were performed in accordance with the tenets of the Declaration of Helsinki after approval by the Ethics Research Committee of the UNICAMP (CAAE nº 45215021.7.1001.5404).

RESULTS

The sample consisted of 472 elderly patients (236 per group) who underwent cataract surgery. There were 272 (57.6%) were men and 200 (42.4%) women; the distribution was symmetrical between the two groups. The median age (IQR; range) was 66 (13; 50-89) years in Group 1 and 66 (13; 50-88) years in Group 2 (p=0.450). The median age (IQR; range) was 67 (11; 50-89) years for men and 65.5 (16; 50-88) years for women (p=0.866).

The median AL (IQR, range) in all patients was 23.15 (1.27; 20.34-31.34) mm. The median AL (IQR; range) was 22.82 (1.51; 20.34-28.71) mm in Group 1 and 23.32 (1.45; 20.51-31.34) mm in Group 2 (p<0.001). The median AL (IQR; range) was 23.34 (1.52; 20.64-31.34) mm in men and 22.76 (1.45; 20.34-28.71) mm in women (p<0.001). Table 1 displays the AL data according to the educational level (Group 1 vs. Group 2) stratified by sex.

DISCUSSION

This is the first Brazilian study that utilized optical biometry to provide evidence of a positive association between the AL and educational levels. A higher AL was associated with a higher level of education in elderly patients with cataracts who were not exposed to electronic devices during the first two decades of life. These findings were observed in both sexes.

The association of a longer AL with a higher education level in our study is in agreement with the results of previous population-based studies[1,2,4,6,9-11]. Regarding sex variations, we observed that women had shorter eyes than men, which was already reported by other authors[1-3,7,8,10,12].

Exposure to lifestyle changes resulting from a combination of reduced outdoor time and increased near-vision work activities in the early years lead to refractive error and myopia[2,4,5,10,13]. The mechanism for myopic refractive error appears to be axial elongation. Among environmental factors, the so-called high-pressure education system, especially at young ages, can be a causative lifestyle change as well as the excessive use of electronic devices such as smartphones, tablets, and video games[2,13]. Palliative measures in the ocular growth phase (childhood and adolescence), such as regular breaks during activities requiring near-vision (e.g., reading), increase in outdoor activities, and reduction of children's screen time, and pharmacological measures (atropine eye drops in low concentrations) in selected cases seem capable of counteracting the increased risk of myopia[14-16]. However, the incidence of axial myopia has increased over the last few decades[17]. Therefore, strategies aimed at reducing the prevalence of high myopia should be considered, since complications associated with this ocular pathology have already been reported[18].

In our study, having a higher level of education was a strong determinant for a longer AL; as the patients were born between 1930 and 1970, they were not exposed to electronic devices during childhood and adolescence.

The following limitations must be considered. First, the relationship between biometric characteristics and refraction has not been evaluated due to lens opacification in these patients. Second, there were no data available on outdoor activities. Finally, we cannot exclude selection bias because the study was clinic-based and may not be representative of the entire population.

In conclusion, a longer AL was associated with a higher level of education in elderly patients with cataracts, suggesting that myopization was related to an increase in activities requiring near-vision, which existed even before exposure to electronic devices.

Table 1. Axial length according to educational level (Group 1 vs. Group 2) stratified by sex

Sex	Group 1	Group 2	p
Male[a]	23.13 (1.53; 20.64-26.60)	23.50 (1.30; 21.17-31.34)	0.002[b]
Female[a]	22.33 (1.23; 20.34-28.71)	23.15 (1.37; 20.51-26.96)	<0.001[b]

[a]= median (IQR; range) mm; [b]= Mann-Whitney U test comparing patients in Group 1 vs. Group 2; Group 1 included those who completed, at most, elementary school (including the illiterate and those who partially or totally attended elementary school), corresponding to 12 years of schooling; Group 2 included, at least, high school graduates (including those who completed high school and those who partially or fully attended university).

REFERENCES

1. Foster PJ, Broadway DC, Hayat S, Luben R, Dalzell N, Bingham S, et al. Refractive error, axial length and anterior chamber depth of the eye in British adults: the EPIC-Norfolk Eye Study. Br J Ophthalmol. 2010;94(7):827-30.
2. Wong TY, Foster PJ, Johnson GJ, Seah SK. Education, socioeconomic status, and ocular dimensions in Chinese adults: the Tanjong Pagar Survey. Br J Ophthalmol. 2002;86(9):963-8.
3. Wickremasinghe S, Foster PJ, Uranchimeg D, Lee PS, Devereux JG, Alsbirk PH, et al. Ocular biometry and refraction in Mongolian adults. Invest Ophthalmol Vis Sci [Internet]. 2004[cited 2021 Nov 21];45(3):776-83. Available from: Global Prevalence of Myopia and High Myopia and Temporal Trends from 2000 through 2050 - Ophthalmology (aaojournal.org)
4. Holden BA, Fricke TR, Wilson DA, Jong M, Naidoo KS, Sankaridurg P, et al. Global prevalence of myopia and high myopia and temporal trends from 2000 through 2050. Ophthalmology. 2016; 123(5):1036-42.

5. Lee KE, Klein BEK, Klein R, Quandt Z, Wong TY. Association of age, stature, and education with ocular dimensions in an older white population. Arch Ophthalmol. 2009;127(1):88-93.
6. Rozema JJ, Dhubhghaill SN. Age-related axial length changes in adults: a review. Ophthalmic Physiol Opt. 2020;40(6):710-7.
7. Lira RP, Arieta CE, Passos TH, Maziero D, Astur GL, do Espirito Santo ÍF, et al. Distribution of ocular component measures and refraction in Brazilian school children. Ophthalmic Epidemiol. 2017;24(1):29-35.
8. Chen H, Lin H, Lin Z, Chen J, Chen W. Distribution of axial length, anterior chamber depth, and corneal curvature in an aged population in South China. BMC Ophthalmol [Internet]. 2016 [cited 2021 May 24];16(1):47. Available from: Distribution of axial length, anterior chamber depth, and corneal curvature in an aged population in South China (nih.gov)
9. Bikbov MM, Kazakbaeva GM, Gilmanshin TR, Zainullin RM, Arslangareeva II, Salavatova VF, et al. Axial length and its associations in a Russian population: The Ural Eye and Medical Study. PLoS One [Internet]. 2019[cited 2020 Jun 21];14(2):e0211186. Available from: Axial length and its associations in a Russian population: The Ural Eye and Medical Study (plos.org)
10. Nangia V, Jonas JB, Sinha A, Matin A, Kulkarni M, Panda-Jonas S. Ocular axial length and its associations in an adult population of central rural India: the Central India Eye and Medical Study. Ophthalmology. 2010;117(7):1360-6. Comment in: Ophthalmology. 2011.118(4):785-6; author reply 786.
11. Morgan IG, Wu PC, Ostrin LA, Tideman JWL, Yam JC, Lan W, Baraas RC, He X, Sankaridurg P, Saw SM, French AN, Rose KA, Guggenheim JA. IMI Risk Factors for Myopia. Invest Ophthalmol Vis Sci [Internet]. 2021[cited 2022 Jan 25];62(5):3. from Available from: IMI Risk Factors for Myopia | IOVS | ARVO Journals
12. Liu H, Xu Z, Qian Z, Liang J, Wei K, Zu L, et al. Comparison of ocular biometry profiles in urban and rural cataract candidates in Eastern China. J Ophthalmol [Internet]. 2020[cited 2021 Jul 27];2020:e2863698. Available from: Comparison of Ocular Biometry Profiles in Urban and Rural Cataract Candidates in Eastern China (nih.gov)
13. Morgan IG, Ohno-Matsui K, Saw SM. Myopia. Lancet. 2012; 379(9827):1739-48.
14. Rose KA, Morgan IG, Ip J, Kifley A, Huynh S, Smith W, et al. Outdoor activity reduces the prevalence of myopia in children. Ophthalmology. 2008;115(8):1279-85.
15. Jones LA, Sinnott LT, Mutti DO, Mitchell GL, Moeschberger ML, Zadnik K. Parental history of myopia, sports and outdoor activities, and future myopia. Invest Ophthalmol Vis Sci [Internet]. 2007[cited 2020 Oct 15];48(8):3524-32. Available from: Parental History of Myopia, Sports and Outdoor Activities, and Future Myopia | IOVS | ARVO Journals
16. Dirani M, Tong L, Gazzard G, Zhang X, Chia A, Young TL, et al. Outdoor activity and myopia in Singapore teenage children. Br J Ophthalmol. 2009;93(8):997-1000.
17. Hsiao YT, Fang PC, Wu PC, Kuo MT, Chen YH, Kuo HK. Axial length of cataract eyes: a comparison of two cohorts over a span of 10 years apart. BMC Ophthalmol [Internet]. 2021[cited 2022 Jan 25];21(1):111. Available from: Axial length of cataract eyes: a comparison of two cohorts over a span of 10 years apart (nih.gov)
18. Yu HJ, Kuo MT, Wu PC. Clinical characteristics of presenile cataract: change over 10 Years in Southern Taiwan. Biomed Res Int [Internet]. 2021[cited 2022 Jan 25];2021:9385293. Available from: Clinical Characteristics of Presenile Cataract: Change over 10 Years in Southern Taiwan (nih.gov)