ORIGINAL RESEARCH

Epidemiology and trends in the uptake of refractive error services in Harare, Zimbabwe: a hospital-based retrospective study

Vimbainashe Evidence Kahoto[1], Michael Agyemang Kwarteng[1,2,5*], Bismark Owusu-Afriyie[1], Ebenezer Zaabaar[3], Samuel Kyei[1,3,4]

1. Department of Optometry, Faculty of Science and Engineering, Bindura University of Science Education, Bindura, Zimbabwe
2. Discipline of Optometry, College of Health Science, University of KwaZulu-Natal, South Africa
3. Department of Optometry and Vision Science, School of Allied Health Sciences, College of Health and Allied Sciences, University of Cape Coast, Cape Coast, Ghana
4. Biomedical and Clinical Research Center, University of Cape Coast, Cape Coast, Ghana
5. Optmentry Unit, Department of Clinical Surgical Sciences, The University of the West Indies, St Augustine Campus, Trinidad and Tobago, West Indies

***Corresponding Author: Michael Agyemang Kwarteng**; E-mail: kwartengmichaelagyemang@gmail.com

Abstract

Aim

The study aimed to determine the epidemiology and evaluate the trends in the uptake of refractive error services in Harare.

Methods

A clinic-based retrospective study at the Greenwood Park Eye Centre and its three subsidiaries was conducted from January 1, 2015 to December 31, 2020.

Results

12,216 patients' records were retrieved, out of which 1074 (8.79%) had refractive error cases. The prevalence of visual impairment at presentation was 5.80% [95% CI: 5.39 – 6.23]. Among those with refractive error, the sample prevalence of visual impairment before correction was 41.30% [CI: 38.3 – 44.3, 95%], and 2.20% [95% CI: 1.4 – 3.3] after correction. There was inconsistency in the percentage utilization of refractive error services, with the highest being 42.60% in 2015. Refractive error types were related to age, employment position, and type of visual impairment prior to refractive error treatment.

Conclusion

There was a low percentage of refractive error services uptake in urban Zimbabwe.

Keywords: refractive error, visual impairment, refractive services, Zimbabwe

Introduction

Visual impairment impacts quality of life and productivity negatively and can lead to loss of educational and employment opportunities[1,2]. Over 2.2 billion people are visually impaired worldwide, with about half living with preventable eye conditions[1,2]. Uncorrected refractive error remains the leading and most easily avoidable cause of visual impairment[3]. Despite the rise in popularity of laser surgery, the dominant and cheapest treatment for refractive error correction remains eyeglasses or contact lenses[1,2]. A larger number of persons with refractive error could have their vision restored by this means. More than 500 million people, predominantly in developing countries, have uncorrected refractive errors as the cause of their impaired vision[1,2]. Studies in Africa have reported high cost to the end-user of eyeglasses or contact lenses as a major barrier to the uptake of refractive error services[4–6].

Few studies[5,6] have evaluated trends in refractive service uptake in Africa, with little or no evidence in Zimbabwe[7]. However, among the rural population, a significant percentage (56.8%) of individuals reportedly have visual impairment[7]. Consequently, advocacy for the advancement of equitable and inclusive strategies to increase access to quality refractive services in Zimbabwe has always lacked the necessary evidence to justify this course of action[7]. Greenwood Park Eye Centre and its three subsidiaries (Optinova Eye Care Services) is a private eye care institution that has the full array of eye care professionals providing refractive error services to those covered by insurance (government and private insurers) and uninsured eye care seekers in Harare and beyond. The centre is patronised massively due to its indigenous ownership and long-standing track record in the provision of comprehensive eye care. Meanwhile, there is paucity of information on the dynamics of the uptake of refractive error services in Zimbabwe which can be utilized to inform health promotion policies and eye care strategies. Therefore, this study aimed at determining the epidemiology and trends in the uptake of refractive services in an urban setting in Zimbabwe.

Methods

This was a clinic-based retrospective study conducted at the Greenwood Park Eye Centre premises and three of its affiliates located in the central part of Harare, Zimbabwe. The eye centres were managed by three optometrists with Doctor of Optometry qualifications who examined patients. This study involved a review of patients' records with a history of access to refractive error services at the centres from January 1, 2015 - December 31, 2020. Information was collected on the recorded visual acuity, clinical refraction, anterior and posterior segment eye examinations, and demographics.

https://dx.doi.org/10.4314/mmj.v35i4.3

Table 1 Demographics on the uptake of refractive error services according to sex

Demographics		Sex of Patient		Total (%)	P-value
		Male	Female		
Age group	Children (0 - 17)	112	182	294 (9.3)	P<0.001
	Youth (18 - 35)	459	860	1319 (41.7)	
	Adults (36 - 59)	544	721	1265 (40.0)	
	Elderly (> 59)	143	142	285 (9.0)	
Employment	Employed	857	1208	2065 (65.3)	P<0.001
	Unemployed	1	79	80 (2.5)	
	Pensioner	83	58	141 (4.5)	
	Self Employed	45	70	115 (3.6)	
	Student	272	490	762 (24.1)	
Residence	Urban	1174	1756	2930 (92.6)	0.551
	Peri-urban	43	73	116 (3.7)	
	Rural	41	76	117 (3.7)	
Total		1258	1905	3163 (100)	

Table 2 Demographics on the distribution of refractive error according to sex

Demographics		Sex of Patient		Total (%)	P-value
		Male	Female		
Age group	Children (0 - 17)	40_a	44_a	84 (7.8)	P<0.001
	Youth (18 - 35)	145_a	302_b	447 (41.6)	
	Adults (36 - 59)	192_a	241_b	433 (40.3)	
	Elderly (> 59)	58_a	52_b	110 (10.2)	
Employment Status	Employed	304_a	401_b	705 (65.6)	P<0.001
	Unemployed	0_a	38_b	38 (3.5)	
	Pensioner	28_a	21_b	56 (5.2)	
	Self Employed	16_a	29_a	45 (4.2)	
	Student	87_a	150_a	239 (22.0)	
Residence	Urban	414	585	999 (93.0)	0.069
	Peri-urban	13	36	49 (4.6)	
	Rural	8	18	26 (2.4)	
Total		435	639	1074 (100)	

Each subscript letter denotes a subset of sex categories whose column proportions do not differ significantly from each other at the 0.05 level.

Sample size and sampling method

A convenient purposive sampling technique was used as we looked at all the refractive error cases in the facilities. The study included all users' files with a record of access to refractive error services, and only clinical information from the initial visit were included. Records lacking explicit patient information were excluded. Visual impairment was defined as visual acuity worse than 6/12 (0.3 LogMAR)[1,2]. Refractive error was classified as follows; Myopia, spherical equivalent (SE) ≤ -0.50DS, hyperopia as SE ≥ +0.50DS and astigmatism as < -0.50DC in the better-seeing eye[8].

Data collection procedure and tools

Data extraction worksheets were used to collect information

https://dx.doi.org/10.4314/mmj.v35i4.3

Table 3 Trends in the uptake of refractive error services

Year	Rate of uptake of refractive services		Uptake of refractive services		
	%	CI 95%	Male	Female	Total (%)
2015	42.60	39.45 – 45.80	119	290	409 (12.9)
2016	27.43	25.72 – 29.20	396	312	708 (22.4)
2017	23.56	22.11 – 25.07	321	438	759 (24.0)
2018	20.65	19.07 – 22.30	113	398	511 (16.2)
2019	21.76	20.09 – 23.50	201	299	500 (15.8)
2020	40.47	36.76 – 44.26	108	168	276 (8.7)
Total	25.89	25.12 – 26.68	1258	1905	3163 (100)

on socio-demographics as well as the patients' clinical profile. Age, sex, employment, and place of residence were among the socio-demographic data. The clinical profile involved presenting visual acuity at distance and best-corrected visual acuity (VA), as well as refractive status. The presenting and best-corrected visual acuities were measured under photopic conditions at 6 meters using Snellen visual acuity charts with luminance that ranged from 85 to 300 cd/m^2. Non-cycloplegic refractive error was determined using a KR 9000 Autorefractor on all patients (Perlong Medical Equipment Co., Ltd., Jiangsu, China).

Data analysis

The Statistical Package for the Social Sciences (IBM SPSS) version 21 was used to analyse the data (SPSS Inc, Chicago, USA). Descriptive statistics were computed for all variables, and normality tests were performed. Frequencies were used to represent categorical data. Chi-square test was used to determine association and Bonferonni post hoc test was done to find specific differences between groups, (P<0.05).

Ethics approval and consent to participate

The study adhered to the tenets of the Declaration of Helsinki, and ethical approval for the study was obtained from the Research Ethics Committee, Bindura University of Science Education (BUSEREC/0008/2021). Permission was sought from the management of Greenwood Park Eye Centre and its subsidiaries. All data and records generated throughout the study were handled with strict confidentiality in conformity with the institutional policies.

Results

Out of the 12,216 patients' records retrieved from the eye centres' archives, 3,163 (25.89%) accessed refractive error services, out of whom 1,258 (39.8%) were males, and 1,905 (60.2%) were females. Some 1,074 (33.96%) of the patients had refractive errors (639 (59.5%) females) and 708 (22.38%) had other vision impairments. The mean age of patients was 37.20 ± 15.51 years (range: 2 - 97 years). A statistically significant difference (P<0.001) was observed for sex distribution for the uptake of refractive error services and correction (Table 1).

The majority of patients who sought refractive services were youth (18-35 years) (41.7%), followed by adults (36-59 years) (40.0%). Most (92.6%) of the patients resided in the urban centre (See Table 1). Among those with refractive error, the youth (18-35 years) and those employed (which includes the self-employed) formed the majority. There was a significant association between sex, age group and employment status among those with refractive error (P < 0.05), (Table 2).

Trends in the uptake of refractive error services and visual impairment

Refractive error was classed as per visual acuity in the better seeing eye after non-cycloplegic auto-refraction, and most of the patients were dispensed spectacles. The need for refractive error services declined rapidly in 2015 and 2016, followed by a sustained decrease from 2016 to 2018 then an uptick from 2018 to 2019. Between 2019 and 2020, the rate grew dramatically (See Table 3). The total sample prevalence of visual impairment (n = 12,216) was 5.80% [95% CI: 5.39 – 6.23]. The highest prevalence of visual impairment was in 2020 (see Table 4). The overall prevalence of refractive error (n = 12,216) was 8.79% [95% CI: 8.30–9.31], with 86.96% [95% CI: 84.80–88.92] using corrective lenses (n = 1074). Among those with refractive error (n = 1074), the prevalence of visual impairment before correction was 41.30% [95% CI: 38.3 – 44.3], and 2.20% [95% CI: 1.4 – 3.3] after correction. Myopia (72.2%) was the most prevalent kind of refractive error, followed by hyperopia (22.2%) and astigmatism (5.7%). Chi-square analysis revealed a statistically significant relationship between the kind of refractive error and the age group, occupational position, and type of visual impairment prior to treatment (see Table 5).

A Bonferonni post-hoc analysis on the type of refractive error and age group, occupational position and type of visual impairment prior to treatment showed the proportion of the sub groups that had significant associations (Table 5).

Discussion

This study found the prevalence of refractive error and visual impairment to be 8.79% and 5.80%, respectively. This indicates a relatively low prevalence of refractive error and visual impairment compared to the outcome [uncorrected refractive error (54.2%) and visual impairment (56.8%)] of a population-based study conducted among rural Zimbabweans[7]. It is plausible to ascribe the low refractive error prevalence to poor uptake of refractive error services in

a cosmopolitan city in Zimbabwe, possibly due to exorbitant cost to the end-users.

Malu and Ojabo[9] reported a comparatively higher uptake of refractive error in a private eye facility in Nigeria. This variation could be due to socioeconomic disparities, cultural differences and variability in sample size. Studies have shown an association between socio-economic status and eye health[7,10], and earlier investigations have demonstrated a higher prevalence of refractive error and visual impairment among urbanites than in rural dwellers due to high socio-economic indices in urban centres[10–14].

Consistent with the results of previous hospital-based studies in developing countries[15–18], myopia had the highest prevalence. Contrarily, hyperopia was the most occurring refractive error recorded among rural Zimbabweans[7]. The findings of the current study corroborate those in Bhutan and Australia in which significant rural-urban differences in myopia prevalence were reported[19,20]. These variations could be ascribed to differences in socioeconomic indices, educational pressure and time spent outdoors. It is also worth noting that other hospital-based studies in developing countries have reported astigmatism as the commonest refractive error[21,22].

The relatively high refractive error prevalence (59.5%) reported in females by the current study could be attributed to the fact that more females accessed refractive error services compared to males due to the high health-seeking awareness level among females[23]. The findings might prove to be reasonable when compared to what other hospital-based studies have reported[24–26]. Several school-based studies have also indicated a more frequent occurrence of myopia in females than males[27–31]. In contrast, sex prevalence of myopia was the reverse in some hospital-based studies conducted in Yemen[32] and Nigeria[33]. The reason for this variation could not be determined and requires further consideration.

The prevalence of visual impairment at presentation in the present study replicates the findings of Hashemi et al.[34] in a rural setting. However, it is comparatively low when compared to studies conducted in Zimbabwe[7] and in a hospital-setting in South Africa[35]. We found that correction with spectacle and contact lenses reduced the total prevalence of visual impairment remarkably. Budenz et al.[36], reported a reduction in visual impairment from 17.1% to 6.7% after refraction and correction with spectacle in a population-based study in Ghana. Consistent with the current findings, other hospital-based studies have reported higher prevalence of visual impairment in females than in males[24,25]. Studies suggest that the biological effects of female hormones, and socioeconomic factors could affect the uptake of eye care services[37,38].

Coverage of refractive correction varies in different parts of the world and among sex and age[39–43]. We found a correction coverage of 86.96%, which is substantially high when compared to the findings of earlier studies[39–43]. This suggests that the clinical population had a high uptake, but refractive error services, especially if translated to other socioeconomic circumstances in Zimbabwe, would not. Unlike previous studies, ours found higher spectacle covering in females[39–43]. Zimbabwe has a shortage of eye care professionals, making refractive services expensive (benchmark US$30.0 to see a doctor, US$120 for single vision, and US$400 for progressive spectacles). The high uptake of the refractive error correction can also be attributed to the young age of most of the patients, who would require good visual function for their respective jobs to increase productivity and improve their quality of life, albeit the expensive cost of care.

The dramatic growth in the rate of refractive error and the need for refractive error services from 2019 to 2020 can be attributed to the excessive near work, increased digital device use, less outdoor time and increased sedentary lifestyle that resulted from imposed covid 19 restrictions[44,45]. Several studies[44,45] have reported dramatic increases in myopia, the most common refractive error, during and after covid[19]. High Body Mass Index (BMI) resulting partly from a sedentary lifestyle has also been reported to be associated with myopia[46]. Importantly, the BMI may not necessarily be the cause but the possible excessive near work and digital device use associated with a sedentary lifestyle.

Although this study presents important findings on the prevalence of visual impairment and uptake of refractive error correction, it is associated with limitations. The study design severely limits any inference from population-level prevalence. Also, patients' records did not have level of education, making it difficult to verify a stronger relationship between type of refractive error and educational pressure. Nonetheless, the use of only non-cycloplegic refraction might have resulted in more myopic cases since patients with latent hyperopia may be missed especially in children.

In summary, there was a low percentage of refractive error services uptake in urban Zimbabwe. Refractive error types were related to age, employment, and type of visual impairment prior to refractive error treatment. The percentage of visual impairment after correction was low, indicating the importance of extending refractive error services provision.

Authors' contributions

SK conceptualized, and SK and MAK designed the research project. MAK and VEK carried out data the data collection. SK, MAK, BOA and VEK analysed and interpreted the data. EZ and MAK wrote the original draft. MAK wrote the reviews and EZ, BOA edited the manuscript. All authors read and approved the final manuscript.

Acknowledgements

The authors are grateful to the management and staff of Greenwood Park Eye Centre and its three subsidiaries for their support.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Declaration of competing interests

The authors declare that they have no competing interests.

Consent for publication

Not applicable

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

References

1.Steinmetz JD, Bourne RRA, Briant PS, Flaxman SR, Taylor HRB, Jonas JB, et al. Causes of blindness and vision impairment in 2020 and

trends over 30 years, and prevalence of avoidable blindness in relation to VISION 2020: the Right to Sight: an analysis for the Global Burden of Disease Study. Lancet Glob Health. 2021;9(2):e144–60.

2.Burton MJ, Ramke J, Marques AP, Bourne RRA, Congdon N, Jones I, et al. The Lancet Global Health Commission on Global Eye Health: vision beyond 2020. Lancet Glob Health. 2021;9(4):e489–551.

3.Uncorrected refractive error: the major and most easily avoidable cause of vision loss. Comm Eye Health. 2007;20(63):37–9.

4.McCormick I, Mactaggart I, Bastawrous A, Burton MJ, Ramke J. Effective refractive error coverage: an eye health indicator to measure progress towards universal health coverage. Ophthalmic Physiol Optics. 2020;40(1):1–5.

5.Chan VF, Mebrahtu G, Ramson P, Wepo M, Naidoo KS. Prevalence of Refractive Error and Spectacle Coverage in Zoba Ma'ekel Eritrea: A Rapid Assessment of Refractive Error. Ophthalmic Epidemiol. 2013;20(3):131–7.

6.Nsubuga N, Ramson P, Govender P, Chan V, Wepo M, Naidoo KS. Uncorrected refractive errors, presbyopia and spectacle coverage in Kamuli District, Uganda. Afri Vis Eye Health. 2016;75(1): a327.

7.Tagoh S, Kyei S, Kwarteng MA, Aboagye E. Prevalence of refractive error and visual impairment among rural dwellers in Mashonaland Central Province, Zimbabwe. J Curr Ophthalmol. 2020;32(4): 402-407.

8.Hashemi H, Pakzad R, Ali B, Yekta A, Ostadimoghaddam H, Heravian J, et al. Prevalence of refractive errors in Iranian university students in Kazerun. J Curr Ophthalmol. 2020; 32(1): 75-81

9.Malu K, Ojabo C. Refractive errors in patients attending a private hospital in Jos, Nigeria. Niger J Clin Pract. 2014;17(1):106.

10.Jaggernath J, Øverland L, Ramson P, Kovai V, Chan VF, Naidoo KS. Poverty and Eye Health. Health N Hav. 2014;06(14):1849–60.

11.Dandona R. Childhood blindness in India: a population based perspective. Bri J Ophthalmol. 2003;87(3):263–5.

12.He M, Zeng J, Liu Y, Xu J, Pokharel GP, Ellwein LB. Refractive Error and Visual Impairment in Urban Children in Southern China. Invest Ophthalmol Vis Sci. 2004;45(3):793.

13.Zhao J, Pan X, Sui R, Munoz SR, Sperduto RD, Ellwein LB. Refractive error study in children: results from Shunyi District, China. Am J Ophthalmol. 2000;129(4):427–35.

14.Hashim SE, Tan HK, Wan-Hazabbah WH, Ibrahim M. Prevalence of refractive error in malay primary school children in suburban area of Kota Bharu, Kelantan, Malaysia. Ann Acad Med Singap. 2008;37(11):940–6.

15.Al-Ansi M, Sabri N, Senan D, Mohiaddin M, Al-Bakhrani M, Abbas M, et al. Prevalence of Refractive Errors Among Patients Attending Al-Wehdah Teaching Hospital, Ophthalmic Clinic in Dhamar Governorate, Yemen. Annals Med Health. 2020;2(1):7–12.

16.Natung T, Taye T, Lyngdoh LA, Dkhar B, Hajong R. Refractive errors among patients attending the ophthalmology department of a medical college in North-East India. J Family Med Prim Care. 2017;6(3):543–8.

17.Rizyal A, Ghising R, Shrestha RK, Kansakar I. Pattern of refractive errors among patients at a tertiary hospital in Kathmandu. Nepal Med Coll J. 2011;13(3):172–4.

18.Adeoti CO, Egbewale BE. Refractive errors in Mercyland Specialist Hospital, Osogbo, Western Nigeria. Niger Postgrad Med J. 2008;15(2):116–9.

19.Rai BB, Ashby RS, French AN, Maddess T. Rural-urban differences in myopia prevalence among myopes presenting to Bhutanese retinal clinical services: a 3-year national study. Graefe's Arch Clin Exp Ophthalmol. 2021;259(3):613–21.

20.Ip JM, Rose KA, Morgan IG, Burlutsky G, Mitchell P. Myopia and the urban environment: findings in a sample of 12-year-old Australian school children. Invest Ophthalmol Vis Sci. 2008;49(9):3858–63.

21.Majumder M, Das R, Vishwakarma D. A Clinical Study on Prevalence of Refractive Errors without Presbyopia among the Patients Attending O.P.D. in a Tertiary Care Hospital in Assam. Int J Sci Res. 2018;7(1):1176–84.

22.Lawan A, Eme O. Refractive errors in Aminu Kano Teaching Hospital, Kano Nigeria. Niger Postgrad Med J. 2011;18(4):276–8.

23.Lim MT, Lim YMF, Tong SF, Sivasampu S. Age, sex and primary care setting differences in patients' perception of community healthcare seeking behaviour towards health services. PLoS One. 2019;14(10):e0224260.

24.Ajayi IA, Omotoye OJ, Omotoso-Olagoke O. Profile of refractive error in Ekiti, south western Nigeria. Afri Vis Eye Health. 2018;77(1): a415.

25.Besufikad B, Hailemichael W, Tilahun L, Yimam W, Anteneh S. Refractive errors and associated factors among patients visiting BoruMeda Hospital's secondary eye Unit in Dessie Town, South Wollo Zone, Ethiopia. BMC Ophthalmol. 2022;22(1):312.

26.Leo SW, Young TL. An evidence-based update on myopia and interventions to retard its progression. J AAPOS. 2011;15(2):181–9.

27.Bhutia K, Bhutia S, Gupta N, Shenga D. Prevalence of refractive errors among the school-going children in East Sikkim. Indian J Ophthalmol. 2021;69(8):2018. Doi: 10.4103/ijo.IJO_112_21

28.Prema N. Prevalence of refractive error in school children. Indian J Sci Technol. 2011;4(9):1160–1.

29.Abuallut II, Alhulaibi AA, Alyamani AA, Almalki NM, Alrajhi AA, Alharbi AH, et al. Prevalence of Refractive Errors and its Associated Risk Factors among Medical Students of Jazan University, Saudi Arabia: A Cross-sectional Study. Middle East Afr J Ophthalmol. 2020;27(4):210–7.

30.Ahmed I, Mian S, Mudasir S, Andrabi KI. Prevalence of myopia in students of srinagar city of kashmir, India. Int J Health Sci (Qassim). 2008;2(1):77–81.

31.Czepita D, Mojsa A, Ustianowska M, Czepita M, Lachowicz E. Role of gender in the occurrence of refractive errors. Ann Acad Med Stetin. 2007;53(2):5–7.

32.Mohammed Dhaiban TS, Ummer FP, Khudadad H, Veettil ST. Types and Presentation of Refractive Error among Individuals Aged 0-30 Years: Hospital-Based Cross-Sectional Study, Yemen. Adv Med. 2021:5557761.

33.Koroye-Egbe A, Ovenseri-Ogbomo G, Adio A. Refractive Error Status In Bayelsa State, Nigeria. J Niger Optometr Assoc. 2010;16(1): 11-15.

34.Hashemi H, Yekta A, Jafarzadehpur E, Doostdar A, Ostadimoghaddam H, Khabazkhoob M. The prevalence of visual impairment and blindness in underserved rural areas: a crucial issue for future. Eye (Lond). 2017;31(8):1221–8.

35.Maake MM, Oduntan OA. Prevalence and causes of visual impairment in patients seen at Nkhensani Hospital Eye Clinic, South Africa. Afr J Prim Health Care Fam Med. 2015;7(1):728.

36.Budenz DL, Bandi JR, Barton K, Nolan W, Herndon L, Whiteside-de Vos J, et al. Blindness and visual impairment in an urban West African population: the Tema Eye Survey. Ophthalmology. 2012;119(9):1744–53.

37.Schaumberg DA, Nichols KK. The Global Sex Disparity in Blindness and Visual Impairment. Optom Vis Sci. 2006;83(10):700–1.

38.Gong JF, Xie HL, Mao XJ, Zhu XB, Xie ZK, Yang HH, et al. Relevant factors of estrogen changes of myopia in adolescent females. Chin Med J (Engl). 2015;128(5):659–63.

39.Ezelum C, Razavi H, Sivasubramaniam S, Gilbert CE, Murthy GVS, Entekume G, et al. Refractive Error in Nigerian Adults: Prevalence, Type, and Spectacle Coverage. Invest Ophthalmol Vis Sci. 2011;52(8):5449.

https://dx.doi.org/10.4314/mmj.v35i4.3

40.Bourne RRA, Dineen BP, Huq DMN, Ali SM, Johnson GJ. Correction of Refractive Error in the Adult Population of Bangladesh: Meeting the Unmet Need. Invest Ophthalmol Vis Sci. 2004;45(2):410.

41.Kuang TM, Tsai SY, Hsu WM, Cheng CY, Liu JH, Chou P. Correctable Visual Impairment in an Elderly Chinese Population in Taiwan: The Shihpai Eye Study. Invest Ophthalmol Vis Sci. 2007;48(3):1032.

42.Fotouhi A. Uncorrected refractive errors and spectacle utilisation rate in Tehran: the unmet need. Bri J Ophthalmol. 2006;90(5):534–7.

43.Zhu M, Tong X, Zhao R, He X, Zhao H, Liu M, et al. Visual impairment and spectacle coverage rate in Baoshan district, China: population-based study. BMC Public Health. 2013;13:311.

44.Yang X, Fan Q, Zhang Y, Chen X, Jiang Y, Zou H, et al. Changes in Refractive Error Under COVID-19: A 3-Year Follow-up Study. Adv Ther. 2022;39(6):2999–3010.

45.Cyril Kurupp AR, Raju A, Luthra G, Shahbaz M, Almatooq H, Foucambert P, et al. The Impact of the COVID-19 Pandemic on Myopia Progression in Children: A Systematic Review. Cureus. 2022;14(8): e28444

46.Peled A, Nitzan I, Megreli J, Derazne E, Tzur D, Pinhas-Hamiel O, et al. Myopia and BMI: a nationwide study of 1.3 million adolescents. Obesity (Silver Spring). 2022;30(8):1691–8.