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# Patterns of Refractive Errors among Medical Students at the University of Zambia School of Medicine

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***Authors' contributions***

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## ABSTRACT

**Background:** Uncorrected refractive error is one of the leading causes of visual impairment and blindness world-over. The distribution and pattern of presentation is variable depending on various factors. Regardless of the type, refractive errors are easily correctable with spectacles if diagnosed early.
**Objective:** The objective of this study was to evaluate the pattern of refractive errors among medical students at University of Zambia - School of Medicine.
**Methodology:** This was a cross-sectional study conducted at the University Teaching Hospitals-Eye Hospital involving Master of Medicine, Master of Surgery (MBChB) students from third to seventh year of study at University of Zambia - School of Medicine, Ridgeway campus between October 2021 and March 2022. A total of 210 participants were recruited in the study. Subjects had non-cycloplegic autorefraction combined with a researcher administered questionnaire. Spherical

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equivalents (SE) ≥ - 0.50D were determined as myopia; SE of ≥ + 0.50D hyperopia and ≥ -0.50D cylinder as astigmatism. Statistical analysis was carried out using Stata version 13.0.
**Results:** One hundred and forty-one (67.1%) subjects had a form of refractive error; 56.0%, 31.2% and 12.8% of them were astigmats, myopes or hyperopes, respectively. The prevalence of ametropia was 65.0 % in females and 69.0 % in males. Minus spherical errors ranged from -0.25 to -5.00D and plus spherical errors ranged from +0.25 to +3.00D. The mean spherical equivalent for the group was -0.45D. Parental history of refractive error was significantly associated with diagnosis of refractive error (p=0.001) while age and gender were not (p = 0.428 and 0.530, respectively). The majority (68.6%) of participants were not aware of their refractive error.
**Conclusion:** The prevalence of refractive errors among medical students was high, with astigmatism being the most common type. The majority of those found with refractive error were not aware of the diagnosis.

*Keywords: Visual impairment; medical students; refractive error; astigmatism.*

## 1. INTRODUCTION

Uncorrected refractive error is one of the most common causes of visual impairment and blindness around the world. Globally, the major causes of visual impairment are uncorrected refractive errors, cataract, and glaucoma with prevalence of 42%, 33% and 2%, respectively [1,2]. Uncorrected refractive errors are also a significant cause of blindness (18% of all cases), only second to cataracts (39% of all cases) [3]. Despite being correctable simply with spectacles and contact lenses, refractive errors present a reasonably large economic burden [4,5]. Epidemiological studies indicate that among the refractive errors, prevalence of myopia is increasing worldwide especially in economically developed societies, even reaching epidemic proportions in some [6]. This is especially true in East-Asian populations like China, Japan, and Singapore [7].

Refractive errors include myopia, hyperopia (or hypermetropia), astigmatism and presbyopia. Myopia or ”short-sightedness” is an optical aberration of the eye whereby objects at infinity are focused in front of the retina, with relaxed accommodation. Individuals with myopia are able to see near objects clearly, but distant objects are blurred [8,9]. This is in contrast to hyperopia or “far-sightedness”, in which light is focused behind the retina due to a short eye or insufficiently curved cornea [7]. In astigmatism, the power of the eye varies in different meridians (i.e., vertical, oblique, horizontal) thus objects at infinity focus on different points in front of or behind the retina [9]. Presbyopia is the inability to focus near objects with advancing age due to age-related reduction in accommodation. Emmetropia is the refractive state of an eye whereby objects at optical infinity are focussed on the fovea with relaxed accommodation. A person regarded as an emmetrope generally has “6/6” vision, or a visual acuity that is not deemed as requiring any corrective lenses [7,9,10].

Data on the prevalence of eye conditions are not routinely collected and published in Zambia. However, Linfield et al. (2012) reported that according to a Rapid Assessment of Avoidable Blindness (RAAB) survey undertaken in Lusaka and Southern province in 2010 in people over 50 years of age, the commonest cause of blindness and visual impairment was cataract (47%) followed by refractive error (20%) [11]. Another RAAB survey undertaken in Muchinga Province in 2017 reported that of the 3.3% who were found to be severely visual impaired, refractive error was the second leading cause at 12%, only second to cataract (63%) [12]. The same survey also found that refractive error was the leading cause of moderate visual impairment at 48%. A more recent survey undertaken in Kafue district among primary and secondary school children found the prevalence of eye diseases to be 20.9%, with significant refractive error accounting for 3.3% [13].

Uncorrected refractive errors are a significant problem because they may lead to loss of productivity with resultant massive reduction of countries’ gross domestic product; they also result in functional, psychological, cosmetic, financial burden for the affected individual and family [14]. In addition, refractive errors are risk factors for various ocular diseases. Myopia, especially high myopia, is associated with open-angle glaucoma, rhegmatogenous retinal detachment, cataract, staphyloma, chorioretinopathy, and chorioretinal atrophy, whereas hyperopia is associated with angle-closure glaucoma, and acute ischaemic optic neuropathy [14,15].

For students, uncorrected refractive errors pose a considerable impact on learning, academic achievement and by extension, employability [16]. Yet information on refractive errors in students is still sparse in Zambia. Available studies on refractive errors have focused mainly on primary and secondary school children in various parts of Africa. Little is known about the prevalence and patterns of refractive errors among university students in the African settings. High prevalence rates of myopia have been reported among medical students across several studies in many countries [4,17-19]. One study in Nigeria found ametropia prevalence of 79.5% among medical students, of which 66.3% was myopia [16].

However, some European studies have reported lower rates although still higher than the average population. For example, a Danish study of 147 medical students (median age 26 years) reported figures of 50% [20]. The high rate of myopia among students, it has been suggested, may be due to the possible link between higher education and intelligence with myopia [21-23] or perhaps the amount of near work that students are inevitably involved in (in the form of long hours of study) which is positively corelated with myopia [24,25].

University of Zambia, School of Medicine (UNZA-SOM) is the oldest and largest public medical university in Zambia, offering degree courses in medicine, nursing, biomedical science, pharmacy, physiotherapy, public health, and environmental health as well as post-graduate courses. The student population comprises of mainly black Zambians from all over the country, with a few international students. Despite the fact that university students make up a good proportion of individuals with refractive errors, most interventions are targeted at young children and adults over the age of forty. Hence, there was need to investigate and document the magnitude and pattern of refractive errors among university students, in particular medical students. It is hoped that the information from this study will add to the existing body of knowledge on this subject.

## 2. METHODOLOGY

The study was a cross-sectional descriptive study done on 210 undergraduate medical students from the University of Zambia-School of Medicine (UNZA-SOM), Ridgeway campus. Examination was done at UTHs-Eye Hospital, where examination equipment and tools were located. Convenient sampling was done on medical students aged between 18 to 40 years inclusive who presented to the UTHS-Eye Hospital voluntarily. Participants were notified of the study via class representatives who made the announcement to their classmates on the social media platform of WhatsApp several times during the study period from October 2021 to March 2022.

Included in the study were all Master of Medicine, Master of Surgery (MBChB) aged 18-40 years old inclusive who consented to participate. Excluded were students in this category with pre-existing ocular disease such as glaucoma, corneal injuries, ulcers, retinal diseases, et cetera, with potential to influence results.

Upon presentation to the UTHs-Eye Hospital, participants' demographic and clinical information including age, gender, year of study, medical history, ocular history, present ocular symptoms, and parental history of refractive error were noted on a questionnaire. The participants underwent visual acuity (VA) check, with the addition of pinhole if less than 6/6. Regardless of VA, they then underwent autorefraction using TOPCON KR-9600 autorefractometer (TOPCON Corporation, Tokyo, Japan). Cycloplegia was not used. Information regarding previous history of refractive error diagnosis and age at diagnosis was recorded. Students found with significant refractive error in either eye were further probed on whether they were aware of it or not; they then underwent subjective refraction and were given a prescription. All data collection and examination were done by the researcher and a research assistant, an experienced optometry technologist. The research assistant underwent an orientation a day prior to the beginning of the study in October 2021.

Spherical equivalent was calculated by the addition of half of cylinder power to the sphere. Ametropia was diagnosed if spherical equivalent was ±0.50D or greater or a sphere/cylinder of ± 0.50 D or greater. The ametropia was then classified according to type. The right eye data was arbitrarily used for all analyses. However, data from both eyes were tabulated side by side for ease of comparison.

The data entry was done using Microsoft Excel 2010 and analysed using Stata Version 13.

## 3. RESULTS

Two hundred and twelve students participated in the study. However, two were excluded because one had a recent history of uveitis, and one had a history of glaucoma. Of the remaining eligible 210 participants, 113 (53.5%) were male, 97 (46.2%) were female, aged between 19 to 39 years (24.7 ± 3.1).

The most common ocular symptoms related to refractive error that were present in the participants were headache when studying (91 students, 43.3%), eye straining (85 students, 40.5%) and difficulty with distance vision (73 students, 34.7%), as shown in Table 1. Ninety students (42.6%) experienced two or more symptoms.

One hundred participants (47.6%) had parents with a history of refractive error while the remaining hundred and ten (52.4%) had parents with no history of refractive error diagnosis, as shown in Fig. 1.

Most students (185 students, 88.1%) had good uncorrected VA of 6/18 or better in the right eye. Few had moderate visual impairment by WHO standards with VA worse than 6/18 up to 6/60 (20 students, 9.5%) while 5 (42.4%) had severe visual impairment with VA worse than 6/60 up to 3/60. There was no student with very severe visual impairment (VA worse than 3/60) in the right eye. Of the 95 students whose vision was worse than 6/6, 81 (85%) had improvement of VA with use of pinhole while the remaining 14 (14.7%) had no improvement. Table 2 shows participants' VA.

One hundred and forty-one (67.1%) (95% CI, 60.3% to 73.5%) participants were designated to have a form of refractive error in which 79 (56.0%), 44 (31.2%) and 18 (12.8%%) of them were astigmats, myopes or hyperopes, respectively. Of the astigmats 42 (29.8) had simple myopic astigmatism, 24 (17%) had compound myopic astigmatism and 13 (9.2%) had mixed astigmatism. Of those with ametropia, 78 (55.3%) were males and 63 (44.7%) were females. The prevalence of ametropia was 65.0% in females and 69.0% in males. The association between refractive errors and gender was not statistically significant (p = 0.530).

**Table 1. Ocular symptoms present in students**

| Ocular symptoms | N = 210 | |
|---|---|---|
| | n | % |
| Eye pain | 45 | 21.4 |
| Eye straining | 85 | 40.5 |
| Headache when studying | 91 | 43.3 |
| Distance vision difficulty | 73 | 34.7 |
| Near vision difficulty | 3 | 1.4 |
| ≥ 2 symptoms | 90 | 42.6 |

**Table 2. Visual acuity**

| Visual acuity | Right Eye frequency | Left Eye frequency |
|---|---|---|
| | N (%) | N (%) |
| **Uncorrected VA** | | |
| ≥ 6/18 | 185 (88.1) | 189 (90) |
| <6/18-6/60 | 20 (9.5) | 14(6.7) |
| <6/60-3/60 | 5 (2.4) | 5(2.4) |
| <3/60-NPL | 0 (0) | 2(0.9) |
| Total | 210 (100) | 210 (100) |
| **VA improvement with PH** | | |
| Improvement | 81(85.3) | 79(81.4) |
| No improvement | 14(14.7) | 18(18.6) |
| Total | 95(100) | 97(100) |

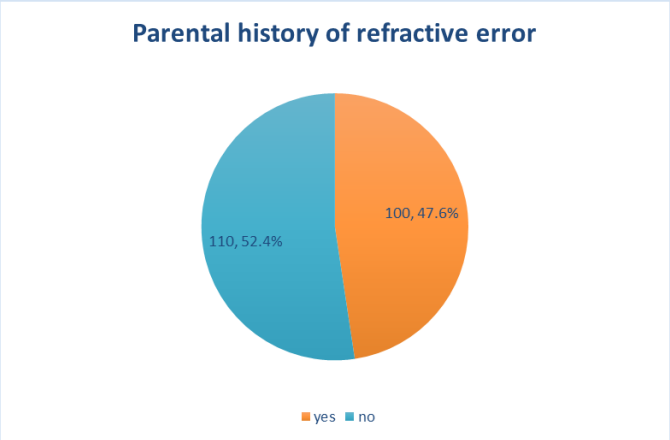


**Fig. 1. Parental history of refractive error**

**Table 3. Pattern of refractive errors**

| | Right Eye frequency N (%) | Left Eye frequency N (%) |
|---|---|---|
| **Sphere (Diopters)** | | |
| ≤ -6.00 | 0 (0) | 1(0.5) |
| -6.00 to < -0.50 | 66 (31.4) | 34 (16.2) |
| -0.50 to < + 0.50 | 109 (51.9) | 122 (58.1) |
| +0.50 to +5.00 | 35 (16.7) | 33 (15.7) |
| Total | 210 (100) | 210 (100) |
| **Cylinders (Diopter cylinders)** | | |
| ≤ 5.25 | 1(0.5) | 1(0.5) |
| - 5.25 to < - 4.45 | 2 (0.9) | 0 (0) |
| - 4.25 to < - 3.25 | 1 (0.5) | 2 (0.9) |
| - 3.35 to < - 2.25 | 1 (0.5) | 1(0.5) |
| - 2.25 to < - 1.25 | 11 (5.2) | 14 (6.7) |
| -1.25 to < -0.25 | 55 (26.2) | 54 (25.7) |
| -0.25 | 68 (32.4) | 59 (28.1) |
| None | 71 (33.8) | 79 (37.6) |
| Total | 210 (100) | 210 (100) |
| **Spherical equivalents (diopters)** | | |
| ≤ -6.00 | 0 (0) | 1(0.5) |
| -6.00 to < -0.50 | 86 (41) | 70 (33.3) |
| < -0.50 to < +0.50 | 105 (50) | 117 (55.7) |
| +0.50 to +5.00 | 19 (9) | 22 (10.5) |
| Total | 210 (100) | 210 (100) |
| **Types of astigmatism** | | |
| Against-the-rule (ATR) | 35 (43.9) | 34 (46.6) |
| With-the-rule (WTR) | 26 (33.1) | 16 (21.4) |
| Oblique | 18 (23.0) | 23 (32.0) |
| Total | 79 (100) | 73 (100) |
| **Types of refractive errors** | | |
| Myopia | 44 (31.2) | 32 (25.6) |
| Simple myopic astigmatism | 42 (29.8) | 36 (28.8) |
| Compound myopic astigmatism | 24 (17.0) | 22 (17.6) |
| Hyperopia | 18 (12.8) | 20 (16.0) |
| Mixed astigmatism | 13 (9.2) | 15 (12.0) |
| Total | 141 (100) | 125 (100) |

Anisometropia (difference in spherical equivalent of 2.00D or more between the two eyes) was not recorded. Minus spherical errors ranged from -0.25 to -5.00 diopter spheres (DS), plus spherical errors ranged from +0.25 to +3.00 DS, while spherical equivalent ranged between -5.13 D and +2.25D. Over half of participants 109 (51.7%) were in the emmetropic or near emmetropic range between + 0.5 to – 0.5 DS in terms of spheres and 139 (66.2%) had little or no cylinder (-0.25 or less). Of the seventy-nine students who had some form of astigmatism, 35 (43.9%) had against-the-rule astigmatism, 26 (33.1%) had with-the-rule astigmatism and 18 (23%) had oblique astigmatism. The mean spherical equivalent in the whole group was -0.45 D (95% CI, -0.63 to -0.34) for the right eye, -0.41 D (95% CI, -0.58 to -0.25) for the left eye and - 0.45 (95% CI, -0.56 to -0.34 for both eyes. This was not statistically significant (p = 0.62, CI, 0.54 to 0.75 by Fischer's Exact Probability Test). There was no student with high myopia. Table 3 shows the pattern of refractive errors.

Sixty-one participants (29.0%) had a previous diagnosis of refractive error prior to the study. The majority of these (56 students, 91.8%) were diagnosed between 11 to 25 years of age, with 30 (49.2%) between 15 to 20 years of age, 13 (21.3%) between 11 to 15 years old and another 13 (21.3%) between 20 to 25 years old. In this study, 141 (67.1%) of participants were found to have a form of refractive error in the right eye. Of the participants who were found with refractive error in either eye (153 participants), the majority (93, 60.8%, 95% CI 52.6% to 68.6%) were not aware of this prior to the study, as shown in Table 4.

Age and gender were not significantly associated with refractive error. Parental history of refractive error was significantly associated with refractive error (p=0.001) as shown in Table 5.

**Table 4. Awareness of diagnosis**

| | **n (%)** |
|---|---|
| **History of refractive error diagnosis** | |
| Yes | 61(29.0) |
| No | 149 (71.0) |
| Total | 210 (100) |
| **Age at diagnosis** | |
| 5-10 | 4 (6.6) |
| 11-15 | 13 (21.3) |
| 15-20 | 30 (49.2) |
| 20-25 | 13 (21.3) |
| 25-30 | 1 (1.6) |
| Total | 61 (100) |
| **Refractive error found in current study** | |
| **Right eye only** | |
| Yes | 141 (67.1) |
| No | 69 (32.9) |
| Total | 210 (100) |
| **Right or left eye** | |
| Yes | 153 (72.9) |
| No | 57 (27.1) |
| Total | 210 (100) |
| **Participant aware of diagnosis?** | |
| Yes | 60 (39.2) |
| No | 93 (60.8) |
| Total | 153 (100) |

**Table 5. Association between refractive error and age/ gender/ parental history**

| Characteristic | N=141 | |
|---|---|---|
| | Refractive error present n (%) | Chi-square test; p value |
| **Age Category** | | |
| 18-25 years old | 97 (68.8) | |
| 26-30 years old | 36 (25.5) | |
| 31-33 years old | 6 (4.3) | |
| 36-40 years old | 2 (1.4) | 0.428 |
| **Gender** | | |
| Male | 78 (55.3) | |
| Female | 63 (44.7) | 0.530 |
| **Parental history of refractive error** | | |
| Yes | 78 (55.3) | |
| No | 63 (44.7) | 0.001 |

## 4. DISCUSSION

### 4.1 Demographic Characteristics of Participants

Participants in this study were an average of 24.7 ± 3.1 years old (range 19-39 years old). Students below the age of 18 were ineligible to avoid requirement of consent from a parent or guardian [26], while students above the age of 40 were ineligible because of the possibility of presbyopia which sets in around early to mid-40s [27] and would have potentially influenced results by inflating hyperopia prevalence. In this study, there was no volunteer who was excluded on account of age.

There were more males (53.5%) than females (46.2%), likely because the student population at UNZA-SOM comprises more males than females. The difference, however, was not statistically significant. This was also found in a similar study in Nigeria [16] although the sample size was much smaller (83 participants). In contrast, a larger study by Muma et al. [28] had more female than male participants (59.2% and 40.8% respectively), although the difference was not statistically significant.

### 4.2 Clinical Characteristics of Participants

None of the students had any significant medical problem. The most common ocular symptoms related to refractive errors that were present in the participants were headache when studying (91 students, 43.3%), eye straining (85 students, 40.5%) and difficulty with distance vision (73 students, 34.7%). Ninety students (42.6%) experienced two or more symptoms. This is similar to a study in Saudi Arabia where eye pains, eye strains, inability to see distant objects and/or headache while reading where the commonest symptoms among students with refractive error [29]. In that study, the proportion of participants with symptoms was much lower (24.2%).

Slightly less than half (47.6%) of participants had parents with a history of refractive error, the other 52.4% did not. The afore-mentioned study had similar results with 45.3% of participants having a parental history of refractive error.

### 4.3 Examination Findings of Participants

#### 4.3.1 Visual acuity

One hundred and eighty-five students (88.1%) had uncorrected VA of 6/18 or better in the right eye, making up the majority. Few had VA between 6/18 to 6/60 (20 students, 9.5%) and only five (42.4%) had VA worse than 6/60. There was no student with vision worse than 3/60. These findings are like other studies which reveal that most college or university students have vision equal to or better than 6/18. In a Nigerian study of medical students this figure was 95.4% [16]; in a study of medical health sciences students in Ethiopia it was 91.6% [30]; yet in another study of undergraduate and postgraduate college students in China, this figure was 97.3% [31]. Perhaps it should be no surprise because medical students and university students spend a lot of time reading and hence need to have good vision, otherwise they would not keep up with their studies.

Ninety-five of the participants had vision worse than 6/6 and were subjected to VA check with a

pinhole. Eighty-one (85%) had improvement of VA while fourteen (14.7%) had no improvement. Improvement of VA with use of a pinhole is an indicator of presence of refractive error and has been used in some studies instead of refraction [29,32,33]. While this may be used to estimate the prevalence of refractive errors, it does not take into account that some people with 6/6 vision may have hyperopia or astigmatism, yet pinhole test is not usually used on them. And in patients who have refractive error and mild amblyopia, the VA may not improve even if they do not have any other ocular pathology [34].

#### 4.3.2 Pattern of refractive errors

The overall prevalence of refractive errors in this study was 67.1%. This was lower than the prevalence of 79.5% found in medical students in Nigeria [16] and 83.1% found in a Saudi study [35]. It was higher than that found in a similar study in Nepalese students where the prevalence was 58.7% [36] and much higher than 32.24% found among Malay students [37].

The most common type of refractive error found among ametropic students was astigmatism at 56.0%, then myopia at 31.2% and least of all hyperopia at 12.8%. Of the astigmats 42 (29.8) had simple myopic astigmatism, 24 (17%) had compound myopic astigmatism and 13 (9.2%) had mixed astigmatism. The prevalence of astigmatism in this study was much higher than 29.6% recorded among Nepalese students [37], 19.7% in the afore-mentioned Nigerian study [16] and slightly higher than 45.5% recorded among students at a Saudi medical university [35]. It was much lower than the prevalence of 82.2% found in a Singapore study of medical students [4].

The prevalence of myopia in this study (31.2%) was comparable to a study in Turkey [39] where the prevalence was 32.9% among medical students. It was lower than 52.7% found Indian medical students [40], 63.6% found in Nigerian students [16]; 87.6% in Malaysia [36], 89.8% in Singapore [4]. Several other studies have consistently found higher rates of myopia [17,19,41,42].

This study did not find any student with high myopia (right eye), similar to the Nigerian study [16] and in contrast to the Saudi study which found high myopia of 8.04% among the myopes [35] and 3.7% in Nepalese students [37]. It is possible that students with high myopia are symptomatic and seek help as soon as possible. Since these studies are voluntary, they may not capture those who are already wearing spectacles and may not benefit directly from the study.

The prevalence of hyperopia in this study (12.8%) was similar to the 16.7% found in the Nigerian study [16] and 10% found among Malay students 36]. It was much higher than 3.7% found in the Saudi study [35] and 1.3% found in the Singapore study mentioned above [4]. Our prevalence was lower than 23.7% reported in a Pakistani study [43].

Of the 141 participants with ametropia, 78 (55.3%) were males and 63 (44.7%) were females. The overall prevalence of ametropia was 65.0 % in females and 69.0 % in males. The association between refractive errors and gender was not statistically significant in several studies with $p > 0.05$ [4,16,35,42]. In Malaysia, there were more female students than males with refractive error and the difference was statistically significant with $p=0.000$ [36]. An Indian study [40] reported a higher prevalence of ametropia among male students compared to females; the difference, however, was not statistically significant ($p=0.93$).

Amongst the participants with astigmatism, against-the-rule (ATR) astigmatism was the commonest form in our study. This agrees with some studies that report that the prevalence of ATR astigmatism significantly increases with age, and with-the-rule (WTR) astigmatism significantly decreases with age [44-46]. According to Lian-Hong et al. [47], 9 years of age is the critical period for the transition from WTR to ATR astigmatism. Since mean age of our study was 24.7 ± 3.1 years, suffice it to say that the critical age for WTR astigmatism has been exceeded.

Despite extensive literature search of major databases, there was paucity of studies on refractive errors among African university students with which to compare our study. One comparable study was the Nigerian study [16] but the sample size was much smaller (83 students). The other was an Egyptian study [34] whose methods were somewhat similar to our study with an even larger sample size of 278. Both these studies had higher prevalence of refractive error (79.5% and 83.1%, respectively), and higher prevalence of myopia (63.6% and 74.1%, respectively) than our study. However,

just like these studies, our study shows a greater prevalence of refractive errors than would be expected in a general population in an African setting. Epidemiological studies among African school children have reported refractive errors prevalence that ranges from 0.2%-13.5%, myopia (range, 4.3%-7.0%) being the commonest refractive error [28, 48-50]. It is clear that the mean ages of these African studies are much lower than that recorded in the current study. But the differences in age alone cannot account for the huge discrepancy in refractive errors. The Framingham Offspring Eye Study Group in 1996 [51], found the prevalence of myopia to decrease with age in 1585 offspring of 1319 parents. This is expected on account of decreasing growth of the eye after high school. This may explain why our study found lower rates of myopia, given the average age of our participants. The influence of genetics and other environmental factors may explain the differences between our study and afore-mentioned African studies.

#### 4.3.3 Awareness of refractive error diagnosis

Of the participants who were found with refractive error in either eye, 68.6% were not aware of the diagnosis prior to the study. The remaining 31.4% who were aware had been diagnosed before and already wore spectacles. Alruwaili et al. [34] in their study found a higher number of participants who were aware of their refractive error (50.3%) but still considered it to be low. They postulated that this relatively low percentage explained why as much as 51.5% of students enrolled were not using any kind of treatment for refractive error. In this current study, there was a student with high myopia and high astigmatism (in his left eye) and with severe visual impairment (<6/60). Surprisingly, he was completely unaware of this prior to participation in the study. He knew that he had trouble seeing at a distance, so he simply sat in front of the class close to the board for most of his academic life. He was otherwise asymptomatic and so was not bothered to seek medical attention. This pattern of behaviour was noticed among some of his other colleagues with smaller refractive errors although it was not part of the study.

The age at which the majority of participants were diagnosed (11-25 years old) seems to correspond to an age at which an individual can notice symptoms, communicate effectively with a parent or guardian and be able to request to seek medical attention. For those over 18 years, they are able to seek medical attention on their own without need for a chaperon.

#### 4.3.4 Association between refractive error and various factors

In this study, there was no significant association between age and refractive errors (p=0.428). Similarly, Al-Batanony [29] also did not find any significant association between age and refractive errors (p=0.76). A 2014 study by Dey et al., in contrast, found refractive errors to be significantly more in the age range of 18 to 23 compared to older age range [52].

There was no significant association between gender and refractive errors, as already discussed earlier. Parental history of refractive errors was significantly associated with refractive errors in our study (p=0.001). Similar association was found in a number of studies of refractive errors among medical students [28,42,53,54]. It has been hypothesised that an underlying genetic predisposition may alter eye growth which affects the prevalence rates in medical students [55-57]. Like most other studies, these studies have focused on the association between myopia and parental history. In our study where astigmatism was more prevalent than myopia, it is hard to tell whether the association may be explained by the same mechanism or perhaps there is another explanation.

## 5. CONCLUSION

Refractive error is a significant problem among medical students at UNZA SOM. The commonest form of refractive error was astigmatism in its various forms, followed by myopia. There was no difference in prevalence attributable to age or gender, but parental history of refractive error was a significant association. The most common symptoms of refractive error were headache when studying, straining of eyes and difficulty seeing distant objects. Most students with refractive error are not aware that they have it. Most studies among medical students have found myopia to be the most prevalent type of refractive error. There may be need to conduct further studies to find out why this was not the case in this study.

## CONSENT

Written informed consent was obtained from all participants prior to enrollment and data collection.

## ETHICAL APPROVAL

Ethical approval was obtained from the University of Zambia Biomedical Research Ethics Committee for Postgraduates studies (UNZABREC) and the National Health Research Authority (NHRA). Permission was obtained from the UTHS-Eye Hospital and from UNZA-SOM in writing. The study protocols were in keeping with the tenets of Helsinki declaration of 1964 and amended by the 64th World Medical Association (WMA) General Assembly (2013) [57].

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

## REFERENCES

1. WHO fact sheet. No 282 Visual Impairment and Blindness, June 2012. Accessed on 25 August 2021.
Available:http://www.who.int/mediacentre/factsheets/fs282/en/
2. Pascolini D, Mariotti SP. Global estimates of visual impairment:2010. Br J Ophthalmol. 2012; 96(5):614-618.
3. Foster A, Gilbert C, Johnson G. Changing patterns in global blindness: 1988–2008. Community Eye Health Journal. 2008; 21(67):37-39.
4. Woo WW, Lim KA, Yang H, Lim XY, Liew F, Lee YS, Saw SM. Refractive errors in medical students in Singapore. Singapore Med J. 2004;45(10):470-4
5. Hashemi H, Fotouhi A, Yekta A, Pakzad R, Ostadimoghaddam H, Khabazkhoob, M. Global and regional estimates of prevalence of refractive errors: systematic review and meta-analysis. Journal of Current Ophthalmology. 2018;30:3-22.
6. Fredrick DR. Myopia. British Medical Journal. 2002;324(7347):1195-9.
DOI: 10.1136/bmj.324.7347.1195. PMID: 12016188; PMCID: PMC1123161
7. Mutti DO, Mitchell GL, Moeschberger ML, Jones LA, Zadnick K. Parental myopia, nearwork, school achievement, and children's refractive error, Investigative Ophthalmology and Visual Science. 2002;43:3633- 3640.
8. Benjamin WJ. Borish's Clinical Refraction, 2nd edition. St. Louis, MO: Butterworth-Heinemann; 2006.
9. Brodie SE, Gupta PC, Irsch K, Mauger TF, Strauss L, Thali EH, Young JA, editors. Basic and Clinical Science Course 3: Clinical Optics. American Academy of Ophthalmology, San Francisco; 2020.
10. Dhaliwal DK. Overview of refractive error. MSD Manual Professional version. 2022. Accessed 15 April 2022.
Available:https://www.msdmanuals.com/professional/eye-disorders/refractive-error/overview-of-refractive-error.
11. Lindfield R, Griffiths UK, Bozzani F, Mumba M, Munsanje JA. Rapid Assessment of Avoidable Blindness in Southern Zambia. PLoS ONE. 2012;7(6): e38483.
DOI: 10.1371/journal.pone.0038483.
12. Mutati GC. Rapid Assessment of Avoidable Blindness (RAAB): Muchinga Province, Zambia; 2017.
Accessed on 25 August 2021.
Available:https://research.sightsavers.org/wp-content/uploads/sites/8/2019/07/Zambia-RAAB-Report.pdf.
13. Muma K, Nyaywa M, Mwelwa G, Buglass A, Mboni C. Prevalence of Eye Diseases among Learners in Kafue District, Zambia. Medical Journal of Zambia. 2020;47(1): 1-7.
Accessed 26 august 2021.
Available:https://www.mjz.co.zm/index.php/mjz/article/view/632.
14. Foster PJ, Jiang Y. Epidemiology of myopia. Eye (Lond). 2014;28(2):202-280.
DOI: 10.1038/eye.2013.280.
15. Wu P, Huang H, Yu H, Fang P, Chen C. Epidemiology of myopia. Asia Pac J Ophthalmol (Phila). 2016;5(6):386-393.
16. Megbelayin EO, Asana UE, Nkanga DG, Duke RE, Ibanga AA, Etim BA, Okonkwo SN. Refractive Errors and Spectacle Use Behaviour among Medical Students in a Nigerian Medical School. British Journal of Medicine & Medical Research. 2014;4(13):2581-2589.
17. Kinge B, Midelfart A, Jacobsen G, Rystad J. The influence of near-work on development of myopia among university students. A three-year longitudinal study among engineering students in Norway.

Acta Ophthalmologica Scandinavica. 2000; 78(1):26-29.
DOI:10.1034/j.1600-0420.2000.078001026.x

18. Saw S-M, Zhang MZ, Hong RZ, Fu ZF, Pang MH Tan DT. Nearwork activity, nightlights, and myopia in the Singapore-China study. Arch Ophthalmol. 2002; 120(5):620-627.
DOI:10.1001/archopht.120.5.620
19. Kathrotia RG, Avnish DG, Dabhoiwala ST, Patel ND, Pinkesh VR, Elvy R, Oommen ER. Prevalence and Progression of Refractive Errors among Medical Students. Indian J Physiol Pharmacol. 2012;56(3): 284-287.
20. Fledelius H. Myopia profile in Copenhagen medical students 1996-98. Refractive stability over a century is suggested. Acta Ophthalmol Scand. 2000;78:501-5.
21. Wang M, Gan L, Cui J, Shan G, Chen T, Wang X, et al. Prevalence and risk factors of refractive error in Qinghai, China: a cross-sectional study in Han and Tibetan adults in Xining and surrounding areas. BMC Ophthalmol. 2021;21(1): 260.
DOI: 10.1186/s12886-021-01996-2. PMID: 34144693; PMCID: PMC8214277.
22. Gebru EA, Mekonnen KA. Prevalence and Factors Associated with Myopia Among High School Students in Hawassa City, South Ethiopia, 2019. Clin Optom (Auckl). 2022;14:35-43.
DOI: 10.2147/OPTO.S308617. PMID: 35299899; PMCID: PMC8921835.
23. Wang Q, Klein BE, Klein R, Moss SE. Refractive status in the Beaver Dam Eye Study. Invest Ophthalmol Vis Sci. 1994;35:4344–7.
24. Saw S-M, Wu HM, Seet B, Wong TY, Yap E, Chia KS et al. Academic achievement, close up work parameters, and myopia in Singapore military conscripts. Br J Ophthalmol. 2001;85:855-60.
25. Saw S-M, Tan SB, Fung D, Chia KS, Koh D, Tan DT et al. IQ and the association with myopia in children. Invest ophthalmology Vis Sci. 2004;45(9):2943-2948.
26. Health Professions Council of Zambia Guidelines for good practice in the health care profession. Obtaining patients' informed consent: Ethical Considerations 1st Ed; 2016.
Accessed 10 Oct 2021.
Available: http://www.hpcz.org.zm/wp-content/uploads/2018/07/Guidelines-on-Informed-Consent.pdf.
27. Croft MA, Glasser A, Kaufman PL. Accommodation and presbyopia. Int Ophthalmol Clin. Spring. 2001;41(2):33-46.
28. Muma MK, Kimani K, Kariuki – Wanyoike MM, Ilako DR, Njuguna MW. Prevalence of Refractive errors among Primary School Pupils in Kilungu Division of Makueni District, Kenya. Medical Journal of Zambia. 2009;36(4).
29. Al-Batanony MA. Refractive Errors among Saudi Medical and Pharmacy Female Students: A Questionnaire Survey Study. Journal of Advances in Medical and Pharmaceutical Sciences. 2016;7(1):1-8
Article no. JAMPS.24633.
ISSN: 2394-1111.
30. Getnet M, Akalu Y, Dagnew B, Gela YY, Belsti Y, Diress M et al. Visual impairment and its associated factors among medical and health sciences students at the University of Gondar, Northwest Ethiopia. PLoS ONE. 2021;16(8): e0255369.
Available:https://doi.org/10.1371/journal.pone.0255369.
31. Cai JM, Ye Y, Liang P, Zhang T, Zheng JH, Wang J et al. Frequency of presenting visual acuity and visual impairment in Chinese college students. Int J Ophthalmol. 2020;13(12):1990-1997,
DOI:10.18240/ijo.2020.12.22.
32. El-Bayoumy BM, Saad A, Choudhury AH. Prevalence of refractive error and low vision among school children in Cairo. EMHJ. 2007;13(3):575-9.
33. Ovenseri-Ogbomo GO, Omuemu VO. Prevalence of refractive error among school children in the Cape Coast Municipality, Ghana. Clinical Optometry. 2010;2:59–66.
34. Alruwaili W, Alruwaili M, Alkuwaykibi M, Zaky K. Prevalence and Awareness of Refractive Errors among Aljouf University Medical Students. The Egyptian Journal of Hospital Medicine, 2018;70(1): 29-32.
DOI: 10.12816/0042958.
35. Al-Rashidi SH, Albahouth AA, Althwini WA, Alsohibani AA, Alnughaymishi AA, Alsaeed AA et al. Prevalence Refractive Errors among Medical Students of Qassim University, Saudi Arabia: Cross-Sectional

Descriptive Study. Open Access Maced J Med Sci. 2018;6(5):940-943.
Available:https://doi.org/10.3889/oamjms.2018.197.

36. Karki P, Sijapati MJ, Basnet P, Basnet A. Refractive Errors Among Medical Students. Nepalese Medical Journal. 2018; 1(1):21–23.
Available:https://doi.org/10.3126/nmj.v1i1.20394.
37. Gopalakrishnan S, Prakash MVS, Ranjit KJ. A study of refractive errors among medical students in AIMST University, Malaysia. Indian Medical Journal. 2011;105(11):365-367.
38. Al-Amri A, Almohi BA, Al Walidi NK, Asiri, RSMR. Prevalence of Astigmatism among medical students in King Khalid University and its effects on academic performance. World Family Medicine. 2021;19(4):37-42.
DOI: 10.5742/MEWFM.2021.94025.
39. Onal S, Toker E, Akingol Z, Arslan G, Ertan S, Turan C et al. Refractive Errors of Medical Students in Turkey: One Year Follow-Up of refraction and Biometry. Optm Vis Sci. 2007; 84(3):175–180.
40. Mehta R, Bedi N, Punjabi S. Prevalence of myopia in medical students. Indian J Clin Exp Ophthalmol. 2019;5(3):322-5.
41. Cavazos-Salias CG, Montemayor-Saldaña N, Salum-Rodríguez L, Villarreal-Del Moral JE, Garza-Leon M. Prevalence of myopia and associated risk factors in medical students in Monterrey. Rev Mex Oftalmol. 2019;93(5):246-253.
42. Maqbool S, Rizwan AR, Manzoor I, Qais A, Furqan A, Rehman A. Prevalence of Refractive Errors among Medical Students and Identification of Factors Associated. Life and Science. 2021;2(4):164-168.
43. Available:rg P, Singh L, Raza M, Yadav S. Study of refractive errors in medical students. Indian J Clin Exp Ophthalmol. 2018;4(4):518-520.
44. Fan DSP, Rao SK, Cheung EYY, Islam M, Chew S, Lam DSC. Astigmatism in Chinese preschool children: prevalence, change, and effect on refractive development. Br. J. Ophthalmol. 2004;88: 938-941.
45. Gudmundsdottir E, Jonasson F, Jonsson V. With the rule astigmatism is not the rule in the elderly. Acta. Ophthalmol. Scand. 2000;78:642–646.
46. Guzowski M, Wang JJ, Rochtchina E, Rose KA, Mitchell P. Five-year refractive changes in an older population: the Blue Mountains Eye Study. Ophthalmology. 2003;110(7):1364-70.
DOI: 10.1016/S0161-6420(03)00465-2. PMID: 12867393.
47. Lian-Hong P, Lin C, Qin L, Ning K, Jing F, Shu Z. Refractive Status and Prevalence of Refractive Errors in Suburban School-age Children. Int. J. Med. Sci. 2010;7(6): 342-353.
48. Asare FA,Morjaria P. Prevalence and distribution of uncorrected refractive error among school children in the Bongo District of Ghana, Cogent Medicine. 2021;8:1.
DOI: 10.1080/2331205X.2021.1911414
49. Rudnicka AR, Kapetanakis VV, Wathern AK, Logan NS, Gilmartin B, Whincup PH. Global variations and time trends in the prevalence of childhood myopia, a systematic review and quantitative meta-analysis: Implications for aetiology and early prevention. The British Journal of Ophthalmology. 2016;100(7):882–890.
Available:https://doi.org/10.1136/bjophthalmol-2015-307724.
50. Resnikoff S, Pascolini D, Etya'ale D, Mariotti SP, Pokharel GP. Global magnitude of visual impairment caused by uncorrected refractive errors in 2004. Bulletin of the World Health Organization. 2008;86(1):1-80. Accessed on 20 August 2021.
Available:https://www.who.int/bulletin/volumes/86/1/07-041210/en/
51. The Framingham Offspring Eye Study Group. Familial aggregation and prevalence of myopia in the Framingham Offspring Eye Study. Arch Ophthalmol. 1996;114:326–32.
52. Dey AK, Chaudhuri SK, Jana S, Ganguly P, Ghorai S, Sarkar A. Prevalence of refractive errors in medical students. Int J Health Sci Res. 2014;4(8):98-102.
53. Rizyal A, Sunrait JS, Mishal A. Refractive errors and its associated factors among undergraduate medical students in Kathmandu. NMCJ. 2019; 21(1):26-30.
54. Jessica SD, Kamath SR. Study of refractive errors among medical students of Melaka Manipal Medical College at Manipal in India. Proceedings of the 4th World Conference on Applied Sciences, Engineering and Technology. Kumamato University, Japan 2015 (24-26 October), ISBN 13:9781-930222-1-4:43-5.

55. Yap M, Wu M, Liu ZM, Lee FL, Wang SH. Role of heredity in the genesis of myopia. Ophthalmol Physiol Opt. 1993;13:316-9.
56. Chew SJ, Ritch R. Parental history and myopia – taking the long view. JAMA. 1994;272:1255.
57. World Medical Association. Declaration of Helsinki: Ethical Principles for Medical Research Involving Human Subjects. JAMA. 2013;310(20):2191–2194.
DOI: 10.1001/jama.2013.281053



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