

# Prevalence and Factors Associated with Refractive Errors among University Students at Mbarara University of Science and Technology, Uganda

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## Abstract

**Introduction:** WHO estimated that uncorrected refractive errors are the leading cause of visual impairment and second leading cause of blindness globally. University students are prone to developing refractive errors due to their curriculum that requires a lot of near work affecting their performance and quality of life unknowingly. Genetic and environmental factors are thought to play a role in the development of refractive errors. This study addresses the paucity of knowledge about refractive errors among university students in East Africa, providing a foundation for further research. **Objectives:** To determine the prevalence and factors associated with refractive errors among students in the Faculty of Medicine at Mbarara University of Science and Technology. **Methodology:** This was a cross-sectional descriptive and analytical study in which 368 undergraduate students selected using random sampling were assessed for refractive errors from March 2021-July 2021. Eligible participants were recruited and their VA assessment done after answering a questionnaire. Students whose VA improved on pin hole had subjective retinoscopy and results were compiled and imported to STATA 14 for analysis. **Results:** The prevalence of refractive errors was 26.36% with (95% CI) among university students especially myopia. Myopia is most predominant at 60%, followed by 37% Astigmatism and hyperopia of 3% among

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medical students. Astigmatism consisted of largely myopic astigmatism 72% (26) and 28% (10) compound/mixed astigmatism only. Student positive family history of refractive error was found to have a statistically significant relationship with refractive errors with AOR 1.68 (1.04 - 2.72) (95% CI) and P (0.032). **Conclusion:** The prevalence of refractive errors among university students, especially myopia, was found to be high and family history was associated with students having refractive errors.

## Keywords

Refractive Errors, Prevalence, Myopia, Astigmatism, Hyperopia, Hypermetropia, University, Students, Blindness, Visual Impairment

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## 1. Introduction

Refractive errors (RE) arise when parallel rays of light do not focus on the retina [1]. Common types of refractive errors include myopia (nearsightedness), hyperopia (long-sightedness), and astigmatism [2]. People with refractive errors complain of blurry vision, difficulty reading, headache, eyestrain. Genetic and environmental factors play a major role in the development of refractive errors [3].

Refractive errors are the leading cause of visual impairment (101.2 million people worldwide) [4] [5]. Uncorrected refractive errors are the second leading cause of blindness (6.8 million people blind) globally [4] [5]. Uncorrected refractive errors are recognized as a public health burden as it leads to loss in productivity affecting people's lifestyle, limiting education, employment opportunities of active and healthy individuals [6]. Factors that lead to uncorrected refractive errors include lack of awareness among affected individuals, lack of readily available screening and testing services, insufficient corrections, and cultural disincentives for the use of optical correction in some countries [7].

Refractive error prevalence, more so myopia, is increasing dramatically in the group of people who are getting a higher education level like a university [8]. Students with uncorrected refractive errors strain to read standard-sized print, overhead projection, computer, color discrimination thus impacting their learning, academic achievement, and employability [2]. A study conducted at the University of Trondheim, Norway and another study conducted by different Universities in Kazerun, Iran [9] found that the risk for developing refractive errors was higher in university students than in the general population.

In Uganda, studies done on the prevalence of refractive errors were based on the community and primary schoolchildren with a prevalence of 4.6% [10] and 11.6% respectively. Little is known about refractive errors among university students in Uganda and or East Africa [11].

Refractive errors are a priority for eye disease by the World Health Organization stated in the global initiative 'Vision 2020' for reducing preventable blind-

ness. Information about refractive errors in university students helps in planning effective programs to deal with the problem. This study sought to bridge the existing knowledge gap about refractive errors among university students in Uganda by not only assessing the common refractive errors but also focusing on the likely contributory factors among students in the Faculty of Medicine at Mbarara University of Science and Technology (MUST). It added knowledge by providing information on this subject, emphasizing the need for more screening strategies, correction and further planning.

## 2. Methods

### 2.1. Ethical Statement

This study adhered to the tenets of the Helsinki declaration. Approval of the study was obtained from the faculty of Medicine research committee (Ref: DMS 6) and the research ethics committee (Ref: MUREC 1/7) at Mbarara University of Science and Technology. Informed consent was sought from all the enrolled participants (See **Appendix A**).

This was a cross-sectional descriptive and analytical study conducted among undergraduate students in the Faculty of MUST, Southwestern Uganda from April 2021 to July 2021.

The sample size was calculated using the formula for estimation of a single proportion by Kelsey (Kelsey *et al.*, 1996)

$$n = Z^2 * P(1 - P) / r^2 .$$

where:  $Z$  value = 1.96.

$P$  = the prevalence of refractive errors among university students was assumed to be 54% based on a study conducted at Era's Lucknow Medical College and Hospital [12], this study was used because its sample size suits our study as their population size was similar to our study population size and the margin error of estimation that was assumed to be 5% (0.05). This provided 382 students and to account for the predicted 20% non-response rate, the final sample was 458 students.

### 2.2. Case Definition

A student was diagnosed to have  $n$  refractive error if found with spherical equivalent (SE) calculated as sphere plus half-cylinder of  $\pm 0.50$ . Myopia was defined as a spherical error (SE) of at least  $-0.50$  diopters (D), hyperopia was defined as SE of at least  $+0.50$ D and astigmatism was defined as a cylinder of at least 0.50D [13].

### 2.3. Inclusion Criteria

We enrolled students in the Faculty of Medicine willing to participate by signing the informed consent and with clear visual axes that could not affect the refraction procedure plus those using corrective eyeglasses.

## 2.4. Exclusion Criteria

We excluded students with ocular comorbidities affecting vision for example cornea, lens and vitreous opacities, retinal and macular abnormalities and those with previous ocular surgery affecting vision.

## 2.5. Variables

We enrolled a total of 368 students. The data collected include: socio-demographics, ophthalmic history including lifestyle factors, visual acuities, and results of refraction examination. The WHO Examination form [14] was modified and used to collect data as a questionnaire containing (socio-demographics, ophthalmic history including lifestyle factors, results of refractive examination) that was pretested and found valid for the study.

## 2.6. Data Collection

Instruments used included Retinoscope, pen torch, lensometer, pinhole, direct ophthalmoscope, trial frame and lenses. A questionnaire (**Appendix B**) was used to capture socio demographic data and ocular history. The WHO Examination form was modified and used to collect data [14]. The questionnaire had sections (socio-demographics, ophthalmic history including lifestyle factors, results of refractive examination). A Research Assistant (RA) with qualifications of being a nurse off duty during the time of data collection helped in registration and administering questionnaires to the participants.

Screening of participants for eligibility was done by the PI using a torch and a direct ophthalmoscope. Those who met the inclusion criteria consented, registered, and information about socio-demographics, ophthalmic history, and lifestyle were collected in the same sitting by the RA. Visual acuity was assessed using a Snellen's chart at 6 meters in a well-lit room or open space. Students wearing glasses were assessed with and without them, the refractive power of the glasses was measured using a lensometer. Pinhole acuity was measured in students whose visual acuities were worse than 6/6. And when these student's visual acuity improved with pinhole, the cause of the reduction in vision was considered to be mainly refractive. Therefore, objective refraction was carried out in all those with visual acuity (VA) less than 6/6 that improved with the pinhole by principal investigator and optometrists at Mbarara University Referral & Eye Center, and subjective refraction was performed by achieving best-corrected visual acuity using Snellen's chart. Refractive error was defined as spherical equivalent (SE) calculated as sphere plus half-cylinder. Myopia was defined as a spherical error (SE) of at least  $-0.50$  diopters (D), hyperopia was defined as SE of at least  $+0.50$ D and astigmatism was defined as a cylinder of at least  $0.50$ D [13]. Examination of the anterior segment and posterior segment was done using a pen torch or ophthalmoscope light and the direct ophthalmoscope.

## 2.7. Data Analysis

Data recorded on the pretested questionnaire was entered into EPI INFO ver-

sion 3.5 and exported from EPI INFO to STATA software version 14.0.

Tables and figures were used to display results of descriptive analysis. The prevalence of refractive errors was got and a p-value of 0.05 was used to determine a significant association between refractive errors and independent factors.

### 3. Results

#### 3.1. Socio-Demographic Characteristics of the Study Participants

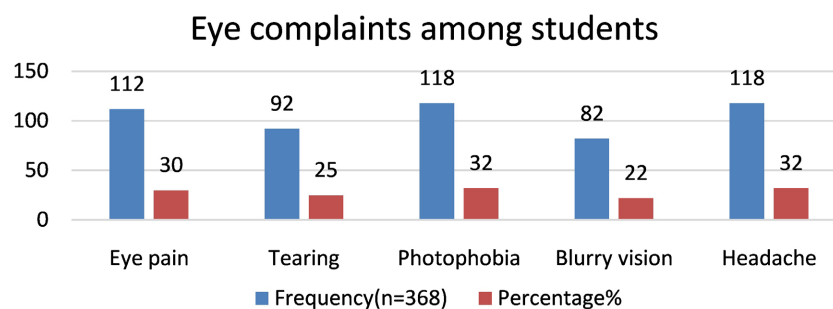
368 students participated in the study to give a response rate of 80.3%. The mean age of the study population was  $22.7 \pm 3.7$  years (range, 18 - 45 years) **Table 1**.

Most of the student participants 94% ( $n = 368$ ) were between 18 - 29 years. Male students were the majority 240 (65%) and 128 (35%) were females. Year 1 students were 29% (105) of the total participants, Year 2 were 30% ( $n = 368$ ) and Year 3 - 4 students were the majority at 41% ( $n = 368$ ).

**Table 1.** Social demographics.

Demographics	Social Demographics		
	Category	Frequency (368)	Percentage%
<b>Age</b>	18 - 29	335	94
	30 - 45	21	6
<b>Sex</b>	Male	240	65
	Female	128	35
<b>Program</b>	Medicine	127	34
	Nursing	64	17
	Physiotherapy	39	11
	Pharmacy	138	38
<b>Year of study</b>	1	105	29
	2	112	30
	3 - 4	151	41

Family history of using prescribed glasses among parents and siblings was reported by 44% (163) and 21% ( $n = 368$ ) reported a history of using corrective glasses. About 85% (308) of the students' participants reported a history of reading for less than 9 hours daily **Table 2**. Photophobia and headache while reading were the major reported complaints among all the students at 32% followed by eye pain at 30% with the least complaint of blurry vision reported at 22% among the students ( $n = 368$ ) as shown in **Figure 1**.



**Figure 1.** Eye complaints among students.

**Table 2.** Students' lifestyle.

Demographics	Students' lifestyle		
	Category	Frequency (368)	Percentage %
<b>History of using glasses by Students</b>			
	Yes	77	21
	No	291	79
<b>Family history</b>			
	Yes	163	44
	No	205	56
<b>Daily reading time</b>			
	8 hours	308	84.9
	More than 8 hours	55	15.2
<b>Reading time</b>			
	Day	138	37.60
	Night	229	62.40
<b>Sleep time</b>			
	Before midnight	165	44.9
	After midnight	202	55.0
<b>Preferred leisure activity</b>			
	Indoor	195	53.3
	Outdoor	171	46.7
<b>Time spent watching television</b>			
	≤3 hours	333	90
	>3	35	10
<b>Time spent on phone</b>			
	≤3 hours	43	12
	>3	325	88
<b>Time spent using computer</b>			
	≤3 hours	193	52
	>3	175	48
<b>Sleep duration</b>			
	≤6 hours	268	73
	>6	100	27

### 3.2. Prevalence of Refractive Errors

Among the 368 students enrolled during our study period, refractive errors were present in 97 of them giving an overall prevalence of 26.36% (See **Table 2**).

**Table 3** shows the prevalence of different types of refractive errors among our students. Most of the students had Myopia (58/97) 60%, followed by Astigmatism (36/97) 37% and Hypermetropia 3%. Astigmatism consisted of largely myopic astigmatism 72% (26) and 28% (10) compound/mixed astigmatism only.

**Table 3.** Types of refractive errors.

Types of refractive errors	Types of refractive errors	
	Frequency	Percentage
Astigmatism	36	37
Myopia	58	60
Hyperopia	3	3
<b>Total</b>	<b>97</b>	<b>100</b>

Among the students found with refractive errors (27/97) 28% were using corrective glasses and of those 30% (8/27) were using glasses that were not correct for their current refractive errors as shown in **Table 4**.

**Table 4.** Glass use among students with refractive errors.

Glass use	Glass use among students with refractive errors.	
	Frequency (%)	Percentage
<b>NO</b>	<b>70</b>	<b>72</b>
<b>YES</b>	<b>19</b>	<b>28</b>
Correct power	8	
Not Correct power		
<b>Total</b>	<b>97</b>	<b>100</b>

### 3.3. Factors Associated with Refractive Errors

In bivariate analysis (**Table 5**), positive family history of parents and siblings using glasses was found to be associated with having refractive errors. In multivariate analysis (**Table 5**), the only factor associated with students having refractive errors was positive family history of parents and siblings using glasses and this was statistically significant p value of 0.05%.

**Table 5.** Bivariate and multivariate analysis results of factors associated with refractive errors.

Factor	Bivariate analysis		Multivariate analysis	
	UOR (95% CI)	P Value	AOR (95% CI)	P (0.0498)
<b>Sex</b>				
Male	1.0	0.072		
Female	1.5 (0.96 - 2.49)			

**Continued**

<b>Age (years)</b>					
18 - 29	1.0	0.228	1.0	0.145	
30 - 45	<b>1.75 (0.70 - 4.37)</b>		1.99 (0.78 - 5.04)		
<b>Study Year</b>					
1	1.0	0.456	High p value (not included)		
2	0.79 (0.42 - 1.46)				
3 - 4	1.00 (0.57 - 1.76)				0.973
<b>Program</b>					
Medicine	1.0	0.656	High p value (not included)		
Nursing	<b>1.16 (0.58 - 2.33)</b>				
Physiotherapy	<b>1.27 (0.56 - 2.85)</b>				0.562
Pharmacy	<b>1.27 (0.73 - 2.21)</b>				0.390
<b>Preferred Leisure activity</b>					
Indoor	1.0	0.546	High p value (not included)		
Outdoor	0.86 (0.54 - 1.38)				
<b>Reading time</b>					
≤8 hours	1.0	0.84	High p value (not included)		
>8 hours	1.06 (0.56 - 2.03)				
<b>Preferred Reading time</b>					
Day	1.0	0.981	High p value (not included)		
Night	1.0 (0.62 - 1.62)				
<b>Family history of refractive errors</b>					
No	1.0	0.056	1.0	0.032	
Yes	<b>1.57 (0.98 - 2.50)</b>		<b>1.68 (1.04 - 2.72)</b>		
<b>Time spent using computer</b>					
≤3 hours	1.0	0.165			
>3	<b>1.3 (0.87 - 2.21)</b>				

**4. Discussion**

This study found a high prevalence of refractive errors among medical undergraduate students in the Faculty of Medicine at Mbarara University of Science and Technology. This result is in accordance with a study at Kolkata Teaching Hospital although they had a smaller study [1]. Medical students could have been involved in intensive near work habits right from their early school days, even before joining medical college and in addition an underlying genetic predisposition and ethnicity may alter eye growth leading to the development of refractive errors [15]. Other studies conducted among medical students with a similar prevalence of refractive errors were in Malaysia, Mymensingh Medical College (MMC) with a prevalence of 32.24% [16] and in Al-Mustansiriya Medi-

cal College with a reported prevalence of about 33% [2]. The prevalence of refractive errors among medical students has been found higher compared to non-medical students in the general population [9].

However, higher prevalence of refractive errors was found among medical students of Baroda Medical College at 54% [8] and at Era's Lucknow Medical College and Hospital at 54% [12]. Similar studies were conducted in Odisha, India with the prevalence of refractive errors of 56% [17] in Saudi Arabia, also reported a similar prevalence of refractive error of 58.6% [18]. The prevalence of refractive errors was found among medical students, a prevalence of 79.5% was reported among medical students in Nigeria [11], a prevalence of 83.1% was found among Aljounf University Medical Students [19]. Refractive errors vary in different nations and regions among medical students probably due to variation in genetic predispositions, environment factors, ethnicity, methodology, non-participation rates, and refraction techniques [1] [20].

Myopia was the commonest type of refractive error followed by astigmatism and lastly, hyperopia similar to most studies. Studies that found high prevalence of myopia among medical students included (81.70%) in Bangladesh [21], and in India 77.7% [12], and 54.5% [17], and also in Malaysia, the myopia of 87.6% (Gopalakrishnan *et al.*, 2011). Medical students have intense studying and exposure to performing near work that could explain the high prevalence of myopia [11]. Medical students have intense studying and exposure to performing near work that could explain the high prevalence of myopia [11]. In addition to the intensive near work associated with the professional courses, genetic and racial traits could play a role in the development of myopia.

Astigmatism in this study was also reported similarly by a study conducted in Saudi Arabia that found medical students with 53.7% astigmatism [22] another study among medical students that reported astigmatism of 33.5% [23]. The reason for similarity could be due to the same screening methods, classification and retinoscopy [1].

Low prevalence of hypermetropia was also reported in studies conducted among Aljounf University medical students with reported hypermetropia prevalence of 3.483% [19], a study conducted among medical students at Era's Lucknow Medical College and Hospital reported (4.5%) hypermetropia [12], (7.3%) hypermetropia were reported among medical students of AIMST University, Malaysia [16] and hypermetropia of (2.73%) was found in students of Al-Mustansiriya Medical College [2]. The low prevalence of hypermetropia may be due to the fact that it is often present from birth owing to low the power of eye lens and abnormal shape of the cornea, small eye size. However, children and young adults compensate for the problem with a very flexible eye lens and therefore hypermetropia usually appears when the eye lens is not flexible at a more advanced age [2].

#### **4.1. Factors Associated with Refractive Errors**

Student positive family history of refractive error was found to have a statistical-

ly significant relationship with refractive errors among the students. Similar results were reported by studies conducted among students in Dow Medical College, Pakistan [24], among medical students of Qassim University, Saudi Arabia [25], among university students of a tertiary care teaching hospital of Kolkata [1], and among students of Nepal Medical College [18]. This association could be due to genetic predisposition from the parents who have refractive errors [20].

## 4.2. Limitations, Conclusion, and Recommendations

### Limitations

Owing to the large student numbers who would come in at any one time and needed to be worked upon quickly, refraction wasn't done by one optometrist.

### Conclusion

The prevalence of refractive errors among medical undergraduate students in the Faculty of Medicine at Mbarara University of Science and Technology was found to be high at 26.36% with Myopia as the commonest refractive error. Student positive family history of refractive error was found to have a statistically significant relationship with refractive errors among the students.

### Recommendations

- 1) Screening of university students upon entry and regular checkup during their study helps detect and differentiate those who already have refractive errors before joining university from those who develop them during the University study.
- 2) Further studies should be carried out on students to determine the genetic predisposition to having refractive errors since family history was associated with having refractive errors.

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## Conflicts of Interest

No conflict of interest related to this submission.

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## Appendices

### A: Research and Ethics Committee Approval Letter



**MBARARA UNIVERSITY OF SCIENCE AND TECHNOLOGY**  
 P.O. Box 1410, Mbarara Uganda. Tel: +256 48433795; Fax: +256 484 20782  
**RESEARCH ETHICS COMMITTEE**  
 E-mail: sec.rec@must.ac.ug

Ref: MUREC 1/7

Date: February 26, 2021

Dr. Kamara Denis  
 Postgraduate student

**Re: Submitted protocol on "Prevalence and factors associated with refractive errors among students of Mbarara University of Science and Technology, Uganda" 12/12-20**

**Type:**  Initial Application  
 Protocol Amendment  
 Letter of Amendment (LOA)  
 Continuing Review  
 Material Transfer Agreement  
 Other, specify: \_\_\_\_\_



Reference is made to the above protocol which was resubmitted to the Research Ethics Committee for reconsideration and approval.

It is noted that you have addressed all the concerns earlier raised by the Committee.

I am pleased to inform you that your study has been approved for a period of one year from February 26, 2021 up to February 25, 2022.

As Principal Investigators of the research, you are responsible for fulfilling the following requirements of approval:

- All co-investigators must be kept informed of the status of the research.
- Changes, amendments, and addenda to the protocol or the consent form must be submitted to the REC for review and approval prior to the activation of the changes. The REC application number assigned to the research should be cited in any correspondence.
- Reports of unanticipated problems involving risks to participants or other must be submitted to the REC. New information that becomes available which could change the risk: benefit ratio must be submitted promptly for REC review.
- Only approved consent forms are used in enrolment of participants. All consent forms signed by subjects and/or witness should be retained on file. The REC may conduct audits of all study records, and consent documentation may be part of such audits.
- Regulations require review of an approved study not less than once per 12-month period. **Therefore, a continuing review application must be submitted to REC eight weeks prior to the above expiration date of February 25, 2022 in order to continue the study beyond the approved period. Failure to submit a continuing review application in timely fashion may result in suspension or termination of the study, at which point new participants may not be enrolled and currently enrolled participants must be taken off the study.**

- You are required to register the research protocol with the Uganda National Council for Science and Technology (UNCST) for final clearance to undertake the study in Uganda.

The following is the list of documents approved in the application:

Document	Language	Version
Proposal	English	2
Data Collection Tool	English	February 2021
Consent forms	English	February 2021

I wish you all the best.

Dr. Francis Bajunirwe  
 CHAIR,  
 MUST RESEARCH ETHICS COMMITTEE



**B: Questionnaire**

Serial No. Date of Interview: DD|\_|\_|/MM|\_|\_|/YY|\_|\_|\_|\_|  
 Interviewer initials

**SECTION A: SOCIODEMOGRAPHICS**

Student ID: |\_|\_|\_|\_|\_| Age (years)  Sex (1: Male; 2: Female)

Program Name: \_\_\_\_\_ Year of study

Region of Origin: (1: Central; 2 Eastern; 3: Northern; 4 Western; 5: Others)

**SECTION B: HISTORY AND EYE SYMPTOMS**

Circle where appropriate:

**B1.** Do you use or have you ever used prescribed eyeglasses/contact lenses?

1 = Yes 2 = No

If No go to **B3**

**B2.** At what age did you start using them? **Years**

**B3.** Are there family members using prescribed eyeglasses/contact lenses?

(1 = Mother or Father 2 = Both 3 = Siblings 4 = None)

If None go to **B5**

**B4.** How do they use eyeglasses? (1 = All the time 2 = Reading only)?

**B5.** How much time in a day do you normally take while reading? **Hours**

**B6.** What time do you prefer to read (1 = Day 2 = Night)?

**B7.** What time do you normally sleep?

(1 = Before 12:00 am 2 = After 12:00 am)

**B8.** Duration of sleep in a day on average (**hours**

**B9.a.** What is your preferred leisure activity (1 = Indoor 2 = Outdoor)?

**B9.b.** What is the average time spent on these activities in a day?

(1 = Indoor **Hours**  2 = Outdoor **Hours**

**B10.** How much time in a day do you normally spend viewing/using the following?

a. Phone **hours**

b. TV **hours**

c. Computer **hours**

**B11.** Tick **Yes/No**. Do you, have it?

	1 = Yes	2 = No		1 = Yes	2 = No
1) Eye Pain	<input type="checkbox"/>	<input type="checkbox"/>	4) Blurred vision	<input type="checkbox"/>	<input type="checkbox"/>
2) Tearing	<input type="checkbox"/>	<input type="checkbox"/>	5) Headache	<input type="checkbox"/>	<input type="checkbox"/>
3) Photophobia	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>

Serial No. Date of Interview: DD|\_|\_|/MM|\_|\_|/YY|\_|\_|\_|\_|  
 Interviewer initials

**SECTION C: VISION ASSESSMENT**

VA Examiner ID

**C1.** A student is wearing corrective lenses? 0: NO; 1: YES

If No Go to **C3**

**C2. Visual Acuity with corrective lenses:**

	CVA
OD	/
OS	/

Visual Acuity cannot be determined (reason)\_\_\_\_\_

**C3. A Uncorrected Visual Acuity (UCVA) C3.B Pin hole if UCVA worse than 6/6**

	UCVA
OD	/
OS	/

	PH, VA
OD	/
OS	/

Visual Acuity cannot be determined (reason)\_\_\_\_\_

Serial No. Date of Interview: DD|\_|\_|/MM|\_|\_|/YY|\_|\_|\_|\_|

Interviewer initials

**SECTION D: REFRACTION**

**D1. Retinoscopy**

	Sphere	Cyl.	Axis
OD			
OS			

Cannot be examined (reason)\_\_\_\_\_

**D2. Subjective refraction (with BCVA)**

	Sphere	Cyl.	Axis	BCVA
OD				/
OS				/

Cannot be examined (reason)\_\_\_\_\_

**D3. Lensometry**

	Sphere	Cyl.	Axis
OD			
OS			

Cannot be examined (reason)\_\_\_\_\_

**Comment**