BOHR International Journal of Current Research
in Optometry and Ophthalmology
2022, Vol. 1, No. 1, pp. 67–73
DOI: 10.54646/bijcroo.2022.18
www.bohrpub.com

REVIEW

A clinical study to assess pattern of contrast sensitivity functions in patients with myopia

Shreya Thatte[1*], Ashima Monga[2] and Haritima Sharma[3]

[1]Professor and Head of Department of Ophthalmology, Sri Aurobindo Medical College and PG Institute, Indore, Madhya Pradesh, India
[2]Senior Resident, Department of Ophthalmology, Sri Aurobindo Medical College and PG institute, Indore, Madhya Pradesh, India
[3]Junior Resident, Department of Ophthalmology, Sri Aurobindo Medical College and PG institute, Indore, Madhya Pradesh, India

***Correspondence:**
Shreya Thatte,
shreyathatte@gmail.com

Received: 29 June 2022; **Accepted:** 05 July 2022; **Published:** 07 October 2022

The COVID-19 pandemic has posed a global threat to public health. In terms of affecting systemic health, it has also created an impact on the ocular health of people. The scenario of work from home and long hours of online classes for students has led to an increase in incidences of refractive error. By affecting visual acuity, it has also posed an increased risk of increasing the degree of myopia. Even in these cases, a patient may have the best corrected visual acuity of 6/6 but he or she may not be satisfied due to improper contrast sensitivity. This study was done to compare contrast sensitivity functions in myopic patients by assessing and comparing various parameters such as demographic factors, age, sex, and profession. We included 500 myopic patients with the best corrected visual acuity of 6/6, without any retinal pathology. Contrast sensitivity functions were compared with astigmatism, degree, and duration of myopia and with the duration of use of spectacles. All three age groups showed a mild decline in contrast sensitivity but the majority consisted of the under-30-year age group with 233 (46.6%) cases. Females being in majority (78.1%) had a mild decrease in contrast sensitivity. We recorded the profession of each patient and observed that there was a mild decline in contrast sensitivity in all professions, and 79.2% of the total students showed a mild decrease in contrast sensitivity, which can be attributed to long hours of screen time in the lockdown phase. Low myopia of less than 3D had a mild decline in contrast sensitivity (88.4%), whereas a severe decline in contrast sensitivity was seen in high myopia (11.9%), which was directly correlated with a degree of myopia. Astigmatism also showed a mild decline in contrast sensitivity, which was 78.5% in compound myopic astigmatism and 88.5% in simple myopic astigmatism. We found a severe decline in contrast sensitivity only in 2.4% of myopic patients with a duration of less than 12 months. The rest of the patients had a mild decline in contrast sensitivity. This validates that contrast sensitivity has an impact on all parameters of the study such as age, gender, profession, duration, degree of myopia, and astigmatism.

Keywords: refractive errors, myopia, contrast sensitivity, Pelli–Robson chart

1. Introduction

Visual acuity is the measure of the spatial resolution of the eye (the clarity or sharpness of vision) and it determines the highest spatial frequency or smallest detail that the eye can perceive at high levels of contrast. However, visual acuity is measured on a fixed target (optotype) and it may be the basic assessment of vision but does not fully meet the daily requirements of the human visual functions, which comes into contact with a variety of stimuli of varying intensity. The purpose of a visual acuity test is to determine the patient's optical performance or sharpness of

vision (1). Contrast sensitivity, which is the ability of the eye to detect small changes in illumination at targets that do not have clearly defined limits, defines the threshold between visible and non-visible, which has both elementary and clinical significance in the science of vision (1). It is just as important and accepted as complementary to visual acuity as it reflects the quality of vision. It is a well-known fact that refractive errors decrease the contrast sensitivity, so in cases where visual acuity is 6/6, a person may not be happy with the quality of his vision and still may complain of decreased vision due to low contrast sensitivity.

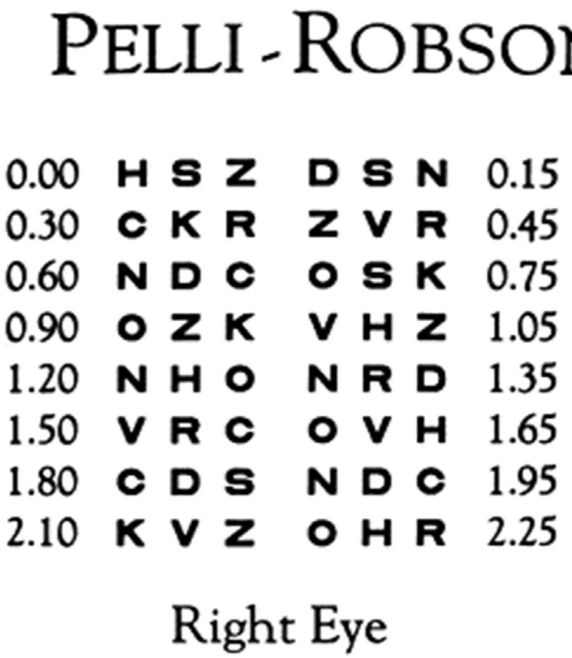

FIGURE 1 | Pelli–Robson chart.

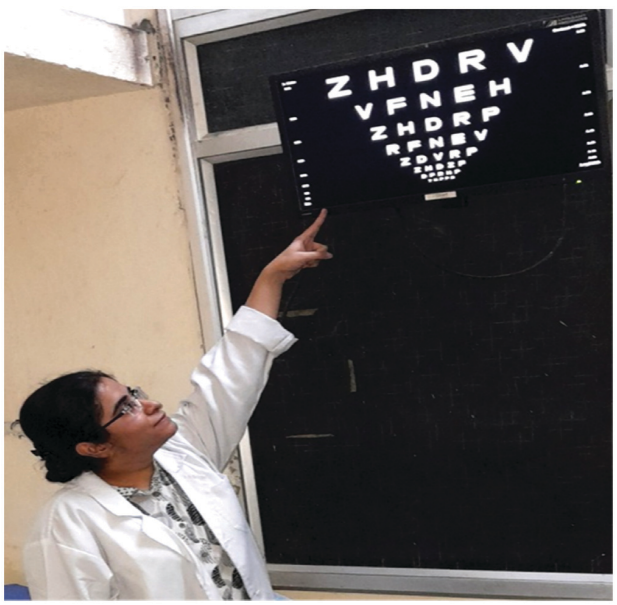

FIGURE 2 | Contrast sensitivity testing by Pelli–Robson chart.

TABLE 1 | Grouping of contrast sensitivity.

Log MAR values	Grade
From 1.5 to less than 2	Mild
From 1 to less than 1.5	Moderate
Less than 1	Severe

TABLE 2 | Grading of myopia.

Myopia in dioptres	Degree of myopia
< 3D	Low myopia
≥ 3Dto < 6D	Moderate
> = 6D	High

Therefore, this study was conducted to evaluate the changes in contrast sensitivity in relation to myopia using the Pelli–Robson chart.

2. Research elaborations

2.1. Methodology

A total of 500 patients with myopia who came to Ophthalmology OPD of a tertiary healthcare center were studied for a period of 1 year, i.e., from 1 June 2021 to 1 June 2022. Only patients who were using glasses with the best corrected visual acuity of 6/6, for the correction of myopia without any retinal pathology, were included in the study. Patients of both genders in the age group of 16–70 years, who were literate, were included after receiving informed written consent. The study was started after the review and approval of the protocol of study by the Institutional Ethical

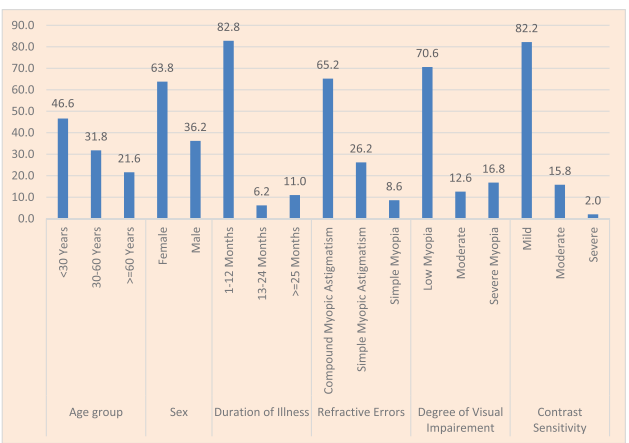

FIGURE 3 | Showing combined parameters and their frequency percentage.

TABLE 3 | Showing the degree of contrast sensitivity in various parameters of the study, with the chi-square values and their significance in the study.

	Contrast sensitivity					
	Mild	**Moderate**	**Severe**	**Total**	**Chi-square**	**Result**
Age group						
< 30 years	190	39	4	233	X^2 = 5.403, df = 4, P = 0.248	Non-Significant
	81.5%	16.7%	1.7%	100.0%		
30–60 years	128	25	6	159		
	80.5%	15.7%	3.8%	100.0%		
> = 60 years	93	15	0	108		
	86.1%	13.9%	0.0%	100.0%		
Total	411	79	10	500		
	82.2%	15.8%	2.0%	100.0%		
Sex						
Female	249	60	10	319	X^2 = 12.564, df = 2, P = 0.002	Significant
	78.1%	18.8%	3.1%	100.0%		
Male	162	19	0	181		
	89.5%	10.5%	0.0%	100.0%		
Total	411	79	10	500		
	82.2%	15.8%	2.0%	100.0%		
Duration of illness						
1–12 months	343	61	10	414	X^2 = 11.678, df = 4, P = 0.020	Significant
	82.9%	14.7%	2.4%	100.0%		
13–24 months	20	11	0	31		
	64.5%	35.5%	0.0%	100.0%		
> = 25 months	48	7	0	55		
	87.3%	12.7%	0.0%	100.0%		
Total	411	79	10	500		
	82.2%	15.8%	2.0%	100.0%		
Degree of visual impairment						
Low myopia	312	41	0	353	X^2 = 68.944, df = 4, P = 0.000	Significant
	88.4%	11.6%	0.0%	100.0%		
Moderate	46	17	0	63		
	73.0%	27.0%	0.0%	100.0%		
Severe myopia	53	21	10	84		
	63.1%	25.0%	11.9%	100.0%		
Total	411	79	10	500		
	82.2%	15.8%	2.0%	100.0%		
Profession						
Athlete	28	2	1	31	X^2 = 20.974, df = 14, P = 0.102	Non-significant
	90.3%	6.5%	3.2%	100.0%		
Doctor	24	4	1	29		
	82.8%	13.8%	3.4%	100.0%		
Driver	23	6	0	29		
	79.3%	20.7%	0.0%	100.0%		
Engineer	51	3	2	56		
	91.1%	5.4%	3.6%	100.0%		
Housewife	21	3	1	25		
	84.0%	12.0%	4.0%	100.0%		
Labourer	21	9	0	30		
	70.0%	30.0%	0.0%	100.0%		
Manager	30	1	0	31		
	96.8%	3.2%	0.0%	100.0%		

(Continued)

TABLE 3 | *(Continued)*

	Contrast sensitivity					
Age group	**Mild**	**Moderate**	**Severe**	**Total**	**Chi-square**	**Result**
Student	213	51	5	269		
	79.2%	19.0%	1.9%	100.0%		
Total	411	79	10	500		
	82.2%	15.8%	2.0%	100.0%		
Refractive Errors						
Compound myopic astigmatism	256	60	10	326	$X^2 = 11.010$, df = 4, P = 0.026	Significant
	78.5%	18.4%	3.1%	100.0%		
Simple myopic astigmatism	116	15	0	131		
	88.5%	11.5%	0.0%	100.0%		
Simple myopia	39	4	0	43		
	90.7%	9.3%	0.0%	100.0%		
Total	411	79	10	500		
	82.2%	15.8%	2.0%	100.0%		

Committee and Research Committee. Contrast sensitivity was recorded by the Pelli–Robson chart (**Figure 1**) with respect to visual acuity by the Snellen chart. The refraction was recorded on the basis of automated refraction, subjective test, and post-mydriatic test (PMT). The data included degree, duration of myopia (which was recorded based on the history and duration of chief complaints), use of spectacles, profession, and the degree of astigmatism and were collected in the form of an excel sheet. The Pelli–Robson chart consists of letters of equal size, in sixteen triplets, with a decrease in brightness of 0.15 log units per triplet. The Pelli–Robson chart measures contrast sensitivity thresholds ranging from 100 to 0.56% and is a simple, easy-to-use, low-cost test with a strong test–retest repeatability. The chart is wall mounted at one meter from the person to be examined and the letter size is 4.9 × 4.9 cm and consists of eight rows of letters (**Figure 2**). **Table 1** shows the contrast sensitivity grouping. The Pelli–Robson chart is easy to use as it resembles the visual acuity measurement that most patients are familiar with; it is fast with good repeatability, as shown in **Figure 3**. Contrast sensitivity is determined by the last triplet letter in which the patient should be able to read at least two. The degree of myopia is shown in **Table 2**. A value of less than 3D corresponds to low myopia, that of equal to or more than 3D and less than 6D is moderate myopia, and that of more than 6D corresponds to high myopia.

3. Results

Refractive error is a known cause of decline in contrast sensitivity in patients. We studied factors such as age, gender, profession, degree of myopia, duration of myopia, and astigmatism, affecting the decline in contrast sensitivity of myopic patients.

Patients were studied in three age groups, namely, under 30 years (233, 46.6% patients), 30–60 years (159, 31.8% patients), and over 60 years (108, 21.6% patients), as shown in **Table 3** and **Figure 4**). It was found that a mild decrease in contrast sensitivity was present in all age groups (81.5, 80.5, and 86.1%, respectively).

A male-to-female ratio was 1:1.76. Notably, 89.5% (162 patients) of males and 73.9% (249 patients) of females showed a mild decline in contrast sensitivity (**Table 3** and **Figure 5**). A severe decline was seen only in 10 (3.1%) females.

Patients were studied in 3 subgroups with durations of myopia of (**Figure 6**) <12 months (414 patients), <13–24 months (31 patients), and ≥25 months (55 patients). A mild decline in contrast sensitivity was noted in all subgroups (82.9, 64.5, and 87.3%, respectively). A total of 10

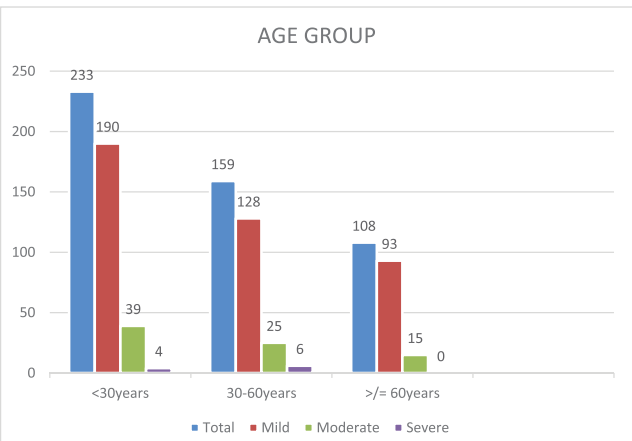

FIGURE 4 | Age and severity of contrast sensitivity.

(2.4%) cases had a severe decline in contrast sensitivity but these patients had myopia with a duration of > 12 years.

The females showing a severe decline in contrast sensitivity also had myopia of high grade with a duration of > 12 months. Therefore, a definitive relation of CS and gender and duration is difficult to establish unless we keep one of these variables constant.

We took into account various professions for comparison with contrast sensitivity such as students (269 cases, 53.8%), engineers (56 cases, 11.2%), managers (31 cases, 6.2%), doctors (29 cases, 5.8%), housewives (25 cases, 5%), athletes (31 cases, 6.2%), drivers (29 cases, 5.8%), and laborers (30 cases, 6%). We found a mild decline in contrast sensitivity in each of the above professions, where the maximum number of cases with a mild decrease was found in students (213 patients, 79.2%) (**Table 3**) (**Figure 7**).

All three grades of myopia showed a mild decline in contrast sensitivity (**Figure 8**), i.e., in low myopia, 312 (88.4%) cases, in moderate myopia, 46 (73%) patients, and in high myopia, 53 (63.1%) cases. A severe decline in contrast sensitivity was seen only in patients with high myopia of more than 6D (10 patients, 11.9%). This shows that as the grade of myopia increases, we see a decline in contrast sensitivity.

A mild decrease in contrast sensitivity was seen in all 3 categories of astigmatism, i.e., 62.3% in compound myopic astigmatism, followed by 28.2% in simple myopic astigmatism and 9.5% in simple myopia. Of note, 3.1% (256, 116, and 39, respectively) of patients with severe loss of contrast sensitivity were found to be having compound myopic astigmatism (**Table 3** and **Figure 9**).

4. Discussion

A vision of the patient is not just the visual acuity. Many parameters affect the visual potential of a person. Visual acuity, color vision, and contrast sensitivity work hand-in-hand for providing good vision to a person (1).To improve the quality of life of a patient with refractive error, sharpness vision plays an important role (2–6). Myopia affecting an estimated 22.9% of the world's population or 1.406 billion people has become a worldwide public health issue (7). Prescribing just glasses to a myopic patient does not always lead to patient satisfaction. We compared contrast sensitivity in myopic patients with demographic profile, i.e., age, sex, occupation, and degree and duration of myopia. We included patients in the age group of 16–70 years. This was similar to the study conducted by Zhouyue Li, Yin Hu et al. (3) which had patients in the age group of 20–70 years. A mild decline in contrast sensitivity was seen in all the age groups (81.5, 80.5, and 86.1%), respectively. A severe decline in CS was seen only in 10 (2.1%) patients. Therefore, a decline in contrast sensitivity was seen in all age groups. However, an incremental relation was not seen. However, many other studies (4, 6, 8) indicated that functions of contrast sensitivity were directly proportional to increasing age and are more severely affected in the old age group of >69 years. This contrast with other studies can be attributed to a smaller sample size (92 patients) in these studies (9) as compared to ours (500 patients). In addition, the age distribution was more toward younger patients (46.6%) in our data in contrast to older patients in data collected by other studies. We had a male-to-female ratio of 1:1.76, which was almost similar to other studies (8, 10) with a sex ratio of 1:1. Notably, 78.1% of females and 89.5% of males had a mild decrease in contrast sensitivity. We could not comment on gender dependence of contrast sensitivity because of the variable distribution of grade and duration of myopia in both genders. To comment on definitive correlation of gender and contrast sensitivity, we need studies with constant grade and duration of myopia. We studied the effect of profession on contrast sensitivity, which to date has not been mentioned in any other study. (10) We noted that professions included by us (students, engineers, athletes, managers, doctors, housewives, laborers, and drivers) had a mild degree of decline in contrast sensitivity. Students being majority (269 cases, 53.8%) had all 3 grades of decline in contrast sensitivity. It can be attributed

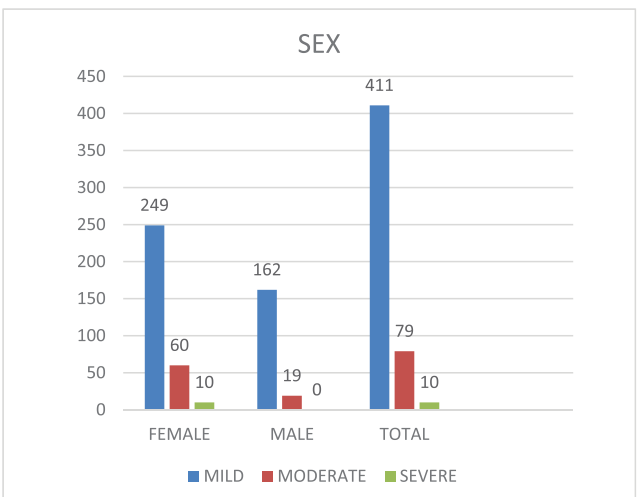

FIGURE 5 | Sex and severity of contrast sensitivity.

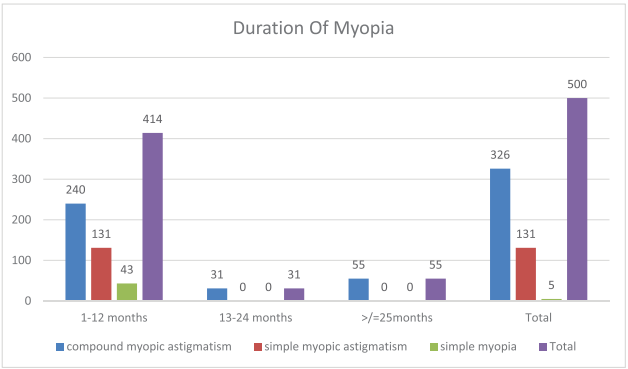

FIGURE 6 | Duration of myopia and severity of contrast sensitivity.

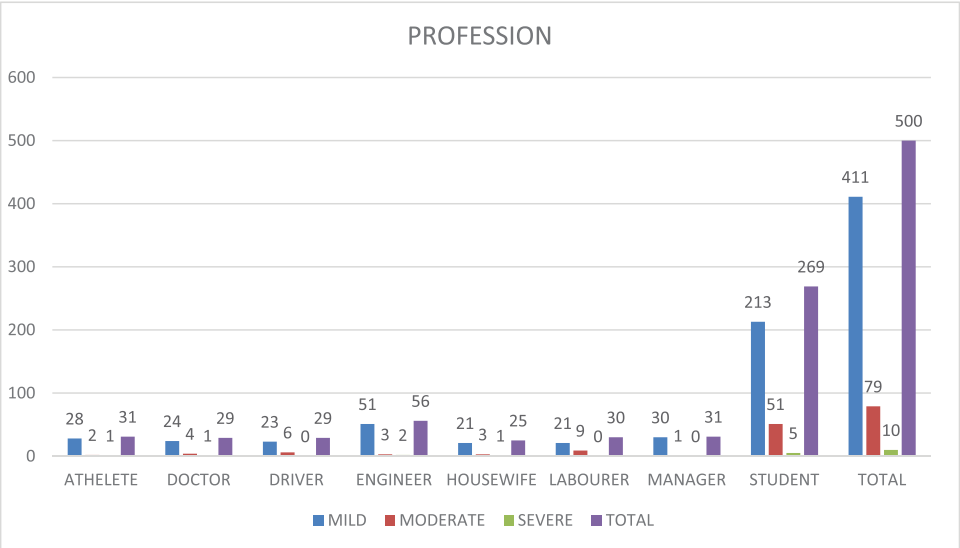

FIGURE 7 | Profession and severity of contrast sensitivity.

to long hours dedicated to laptops and mobile screens during the lockdown phase due to online classes. An increased dependence on mobiles and laptops in every aspect of life such as work from home, buying supplies online, business transactions, and bill payments, compared to the pre-COVID era has contributed to contrast sensitivity being affected as well. Therefore, not only the people involved in the IT sector but also every professional, including housewives, showed a mild decline in contrast sensitivity. These unprecedented conditions of the COVID-19 pandemic have made digital media interface a necessary evil. Therefore, the relationship of contrast sensitivity with the profession of the patient should be explored in the future.

By comparing contrast sensitivity with the degree of myopia, (9, 11) it was interpreted that the majority of them were low myopia and had a mild decrease in contrast sensitivity (312 cases, 88.4%), and in the high myopic group, cases of severe decline in contrast sensitivity were very less (11.9%). We can infer that grade of myopia shows a positive correlation with contrast sensitivity. The duration of myopia was not a significant factor because the time of diagnosis and presence of myopia can be different in the Indian population because of social stigma related to the use of glasses. This was in conflict with the results of the study conducted by Bistra Stoimenova, (12) which suggested that contrast sensitivity is negatively related to the degree and duration of myopia. He studied 60 myopes and showed that 89% of subjects with myopia of more than 10 years had severe decline in contrast functions (9, 16) This contrast in our studies can be attributed to a larger sample size of our study (500 patients) as compared to the aforementioned study (12) (60 patients). Contrast sensitivity and astigmatism were found to have significant relation in our research.

A severe decline in contrast sensitivity was seen in compound myopic astigmatism in 10 (3.1%) cases, whereas maximum (78.5%) cases belonged to mild decline in contrast sensitivity, showing a direct relationship between astigmatism and contrast sensitivity. This was similar to the study conducted by Yumi Hasegawa et al. (13) on 12 emmetropic volunteers, which also suggested that astigmatism deteriorates contrast sensitivity depending on the amount of astigmatic power. The only difference between

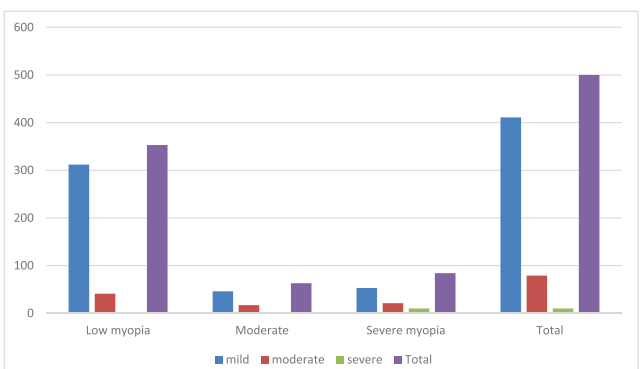

FIGURE 8 | Grade of myopia and severity of contrast sensitivity.

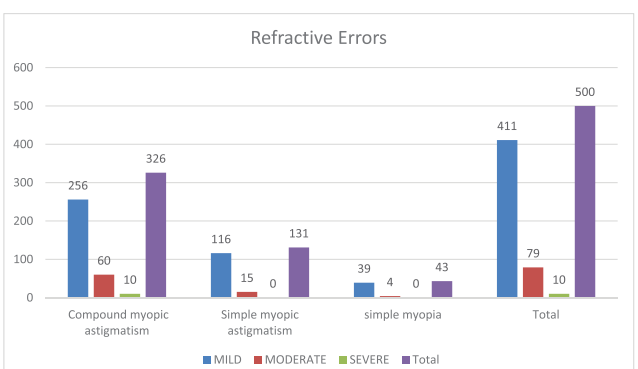

FIGURE 9 | Astigmatism and severity of contrast sensitivity.

the studies was that we did not have any comparison group of emmetropic patients.

5. Conclusion

We concluded from our study that out of 500 patients, there were 82.2% of patients who had a mild decline in contrast sensitivity followed by 15.8% of patients having a moderate decline in contrast sensitivity, whereas only 2% accounted for severe decline in contrast sensitivity. We saw that age and contrast sensitivity are not linearly related. The relationship between gender and duration of myopia is non-definitive because of the variability of parameters. A need for more streamlined studies is reflected in our research. The degree of myopia and astigmatism are positive risk factors for decline in contrast sensitivity. Occupation of the patient had emerged as a new parameter post-COVID era affecting contrast sensitivity, which should be explored more thoroughly. Therefore, the crux of the study is that despite having fully corrected refractive error with a visual acuity of 6/6, myopic patients showed reduced contrast sensitivity, even without any retinal pathology, making it an essential part of a routine ophthalmic examination.

References

1. Daiber H, Gnugnoli D. *Visual acuity*. Treasure Island, FL: StatPearls Publishing (2021).
2. Atowa U, Wajuihian S, Hansraj R. A review of paediatric vision screening protocols and guidelines. *Int J Ophthalmol.* (2019) 12:1194.
3. Dudovitz R, Izadpanah N, Chung P, Slusser W. Parent, teacher, and student perspectives on how corrective lenses improve child wellbeing and school function. *Mater Child Health J.* (2016) 20:974–83.
4. Hinds A, Sinclair A, Park J, Suttie A, Paterson H, Macdonald M. Impact of an interdisciplinary low vision service on the quality of life of low vision patients. *Br J Ophthalmol.* (2003) 87:1391–6.
5. Lundy C, Hill N, Wolsley C, Shannon M, McClelland J, Saunders K, et al. Multidisciplinary assessment of vision in children with neurological disability. *Ulster Med J.* (2011) 80:21.
6. Shah P, Schwartz S, Gartner S, Scott I, Flynn H. Low vision services: a practical guide for the clinician. *Ther Adv Ophthalmol.* (2018) 10:2515841418776264.
7. Holden B, Fricke T, Wilson D, Jong M, Naidoo K, Sankaridurg P, et al. Global prevalence of myopia and high myopia and temoral trends from 2000 through 2050. *Ophthalmology.* (2016) 123:1036–42.
8. Bart van Alphen B, Winkelman B, Frens M. Age-and sex-related differences in contrast sensitivity in C57BL/6 mice. *Investig Ophthalmol Visual Sci.* (2009) 50:2451–8.
9. Liou S, Chiu C. Myopia and contrast sensitivity function. *Curr Eye Res.* (2001) 22:81–4.
10. Solberg J, Brown J. No sex differences in contrast sensitivity and reaction time to spatial frequency. *Percept Motor Skills.* (2002) 94:1053–5.
11. Thorn F, Corwin T, Comerford J. High myopia does not affect contrast sensitivity. *Curr Eye Res.* (1986) 5:635–40.
12. Stoimenova B. The effect of myopia on contrast thresholds. *Investig Ophthalmol Visual Sci.* (2007) 48:2371–4.
13. Hasegawa Y, Hiraoka T, Nakano S, Oshika T. Effects of Astigmatic Defocus on Contrast Sensitivity. *Investig Ophthalmol Visual Sci.* (2012) 53:4805.
14. Li Z, Hu Y, Yu H, Li J, Yang X. Effect of age and refractive error on quick contrast sensitivity function in Chinese adults: a pilot study. *Eye.* (2021) 35:966–72.