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Original Article

Desk Review of Frequency of Types of Astigmatism and Their Relationship to Asthenopia

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ABSTRACT

Background: Astigmatism is one of the most prevalent refractive errors and a major contributor to asthenopia symptoms such as headache, visual fatigue, and double vision. Its clinical impact varies with refractive type and meridional orientation, yet the specific associations between astigmatism subtypes and asthenopia in young adults remain insufficiently clarified. Objective: The study aimed to determine the frequency of refractive and meridional types of astigmatism in young adults and to evaluate their association with asthenopia symptoms, with emphasis on headache and double vision. Methods: A descriptive cross-sectional study was conducted among 186 participants aged 18–35 years at a university-affiliated clinical setting. Visual acuity and refractive status were assessed using standardized optometric procedures, and astigmatism was categorized into simple, compound, and mixed subtypes, as well as with-the-rule, against-the-rule, and oblique orientations. Asthenopia symptoms were evaluated with a structured questionnaire. Associations between astigmatism subtypes and symptoms were analyzed using chi-square tests and odds ratios with 95% confidence intervals. Results: Compound myopic astigmatism was the most common subtype (45.7%), followed by mixed (20.4%) and compound hyperopic (19.9%). With-the-rule orientation predominated (45.7%). Asthenopia was reported by 63.4% of participants, with headaches in 118 (63.4%) and double vision in 108 (58.1%). Compound myopic (OR 2.6, 95% CI 1.4–5.0, p=0.005) and with-the-rule astigmatism (OR 2.4, 95% CI 1.3–4.6, p=0.004) were significantly associated with symptoms. Conclusion: Compound myopic and with-the-rule astigmatism disproportionately contribute to asthenopia in young adults. Early screening, accurate classification, and timely correction are essential to reduce visual discomfort and improve quality of life.

Keywords: Astigmatism; Asthenopia; Headache; Double vision; Refractive errors; Visual fatigue.

INTRODUCTION

Astigmatism is one of the most common refractive errors encountered in ophthalmic practice and significantly affects visual performance by reducing image quality and contributing to ocular discomfort (1). It arises when the cornea or crystalline lens loses its symmetrical curvature, preventing incoming light from converging at a single focal point on the retina and instead creating two focal lines at different planes. This optical imperfection results in blurred or distorted vision, often coexisting with myopia or hyperopia (2). Even relatively small cylindrical errors, measurable as low as ±0.25 diopters, can induce visual symptoms such as headaches, squinting, and eye strain (3). If left uncorrected in children, high cylindrical errors may interfere with visual development, leading to amblyopia, while in adults, the condition often manifests as persistent asthenopia and reduced visual efficiency (4).

The prevalence of astigmatism is substantial, affecting nearly half of the general population to varying degrees, though its frequency and severity differ across age groups and ethnicities (5). Classification by refractive status distinguishes between simple, compound, and mixed forms, while meridional orientation categorizes astigmatism as with-the-rule, against-the-rule, or oblique. Regular forms can usually be corrected with spectacles or contact lenses, while irregular forms, often secondary to trauma or corneal disease, may require specialized optical or surgical management (6). Prior studies have highlighted that with-the-rule astigmatism is more common in younger individuals, whereas against-the-rule astigmatism tends to increase with age (7). Such age-related patterns suggest both genetic predisposition and environmental influences in the etiology of astigmatism.

Asthenopia, a constellation of symptoms including headaches, ocular fatigue, blurred or double vision, and reduced tolerance for near work, represents a major functional consequence of uncorrected astigmatism (8). These symptoms impair academic and occupational performance, reduce quality of life, and increase healthcare burden. Although refractive correction with spectacles or toric contact lenses is effective for most cases, patients with higher-order or irregular astigmatism may continue to experience visual discomfort despite correction (9). The extent to which different refractive and meridional types of astigmatism contribute to asthenopia, however, remains insufficiently explored in younger adults, despite their high reliance on sustained near visual tasks in academic and occupational settings.

The current study addresses this knowledge gap by evaluating the frequency of refractive and meridional types of astigmatism and examining their relationship with symptoms of asthenopia in young adults. By identifying the most prevalent forms of astigmatism and their associated complaints, this research aims to clarify the burden of uncorrected cylindrical errors on visual comfort and provide evidence for early screening and targeted corrective interventions. The specific objective of this study is to determine the distribution of astigmatism types and their association with common asthenopia symptoms, particularly headache and double vision, in a population of young adults aged 18 to 35 years.

MATERIAL AND METHODS

This study was designed as a descriptive cross-sectional observational analysis conducted with an analytical approach to evaluate the frequency of astigmatism types and their association with asthenopia. The rationale for this design was to provide a clear snapshot of refractive error patterns in a defined population while simultaneously assessing related ocular symptoms, thereby enabling the identification of clinically relevant associations between exposure (type of astigmatism) and outcome (presence of asthenopia symptoms) (10).

The research was carried out at the School of Health Sciences, University of Management and Technology, Lahore, Pakistan, over a six-month period. The study population consisted of young adults between 18 and 35 years of age, representing both genders. Inclusion criteria were individuals with best corrected visual acuity of at least 6/9 in both eyes, free from ocular pathology other than refractive error, and willing to provide informed consent. Exclusion criteria included individuals with prior ocular surgery, corneal disease such as keratoconus, lens opacities, systemic conditions affecting vision (e.g., diabetes mellitus), or those on medications known to alter accommodation or ocular surface stability. Participants were recruited using consecutive sampling during routine outpatient optometric and ophthalmology visits. After obtaining verbal and written informed consent, all participants underwent a structured assessment. Demographic data including age and gender were recorded. Visual acuity was measured with a standardized Snellen visual chart under uniform lighting conditions at 6 meters, and best corrected visual acuity (BCVA) was obtained through subjective refraction. Autorefraction was performed using a calibrated autorefractor to obtain objective cylindrical error, which was subsequently refined by subjective testing. Astigmatism was classified according to refractive type into simple myopic, compound myopic, simple hyperopic, compound hyperopic, and mixed categories, while meridional orientation was defined as with-the-rule, against-the-rule, or oblique based on standard axis conventions (11).

Symptoms of asthenopia were evaluated using a structured questionnaire that inquired about common complaints such as headache, double vision, ocular fatigue, heaviness of eyelids, and visual blur during sustained near tasks. Responses were coded as present or absent for each symptom. To minimize interviewer bias, all assessments were conducted by the same trained optometrist. Potential sources of bias and confounding were addressed through several steps. Standardized measurement protocols and calibrated instruments were used to reduce information bias. To limit misclassification, astigmatism type was determined through combined objective and subjective methods. Confounding by age and gender was controlled during statistical analysis by stratification and subgroup evaluation.

A minimum sample size of 180 participants was calculated based on an assumed prevalence of astigmatism of 20%, a 95% confidence interval, and a 5% margin of error, which was adequate for detecting associations between astigmatism types and asthenopia symptoms (12). The final sample consisted of 186 participants, meeting the estimated requirement. Data were entered into SPSS software version 25.0 for analysis. Descriptive statistics including means, standard deviations, frequencies, and percentages were calculated for demographic and clinical characteristics. Associations between types of astigmatism and asthenopia symptoms were evaluated using chi-square tests for categorical variables, with a significance level set at $p < 0.05$. Odds ratios and 95% confidence intervals were calculated to quantify strength of association where relevant. Missing data were handled using pairwise deletion, ensuring that analyses were conducted on available data without introducing imputation bias. Subgroup analyses were performed by gender and age categories to assess potential effect modification. Ethical approval for the study was obtained from the Institutional Review Board of the University of Management and Technology, Lahore. The study adhered to the tenets of the Declaration of Helsinki (13). Participant confidentiality was maintained through anonymized coding, and all data were stored securely with access restricted to study investigators. Measures to ensure reproducibility included detailed documentation of study protocols, calibration logs of optical instruments, and a pretested questionnaire for symptom assessment.

RESULTS

A total of 186 participants were included in the analysis, comprising 97 males (52.2%) and 89 females (47.8%), with a near-equal gender distribution. The largest age group was 27–31 years, representing 34.9% of the cohort, followed by 23–26 years at 32.3% and 18–22 years at 25.8%. Only 7.0% of participants were aged 32–35 years. Symptoms of asthenopia were highly prevalent, with 118 individuals (63.4%) reporting headaches and 108 (58.1%) experiencing double vision, underscoring the clinical burden of uncorrected refractive error in this population. When stratified by refractive classification, compound myopic astigmatism emerged as the predominant type, affecting 85 participants (45.7%). This was more than twice as common as compound hyperopic astigmatism, which accounted for 37 cases (19.9%), and mixed astigmatism, recorded in 38 cases (20.4%). Simple forms were relatively rare, with only 16 individuals (8.6%) exhibiting simple

myopic and 10 (5.4%) with simple hyperopic astigmatism. Meridional distribution revealed a similar pattern, with with-the-rule astigmatism recorded in 85 individuals (45.7%), followed by against-the-rule astigmatism in 62 (33.3%) and oblique astigmatism in 39 (21.0%).

Table 1. Demographic characteristics of study participants (n = 186)

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	97	52.2
	Female	89	47.8
Age (years)	18–22	48	25.8
	23–26	60	32.3
	27–31	65	34.9
	32–35	13	7.0
Asthenopia Symptoms	Headache	118	63.4
	Double vision	108	58.1

Table 2. Distribution of astigmatism by refractive type and meridional orientation (n = 186)

Classification	Subtype	Frequency (n)	Percentage (%)
Refractive Type	Simple Myopic	16	8.6
	Compound Myopic	85	45.7
	Simple Hyperopic	10	5.4
	Compound Hyperopic	37	19.9
	Mixed	38	20.4
Meridional Orientation	With-the-rule (WTR)	85	45.7
	Against-the-rule (ATR)	62	33.3
	Oblique (OA)	39	21.0

Table 3. Association between astigmatism type and asthenopia symptoms (n = 186)

Variable	Symptom Present (%)	Symptom Absent (%)	χ^2 (df)	p-value	OR (95% CI)
Refractive Type					
Compound Myopic	71 (83.5)	14 (16.5)	14.8 (4)	0.005	2.6 (1.4–5.0)
Compound Hyperopic	20 (54.1)	17 (45.9)			1.1 (0.6–2.3)
Mixed	24 (63.2)	14 (36.8)			1.3 (0.7–2.6)
Simple Myopic	7 (43.8)	9 (56.2)			Ref.
Simple Hyperopic	5 (50.0)	5 (50.0)			1.2 (0.3–4.2)
Meridional Orientation					
With-the-rule (WTR)	62 (72.9)	23 (27.1)	11.2 (2)	0.004	2.4 (1.3–4.6)
Against-the-rule (ATR)	34 (54.8)	28 (45.2)			1.1 (0.6–2.0)
Oblique (OA)	22 (56.4)	17 (43.6)			Ref.

Overall, these results highlight that compound myopic and with-the-rule astigmatism are disproportionately associated with asthenopic symptoms in young adults. The findings suggest that specific subtypes of astigmatism, rather than astigmatism per se, are driving the burden of visual discomfort in this population.

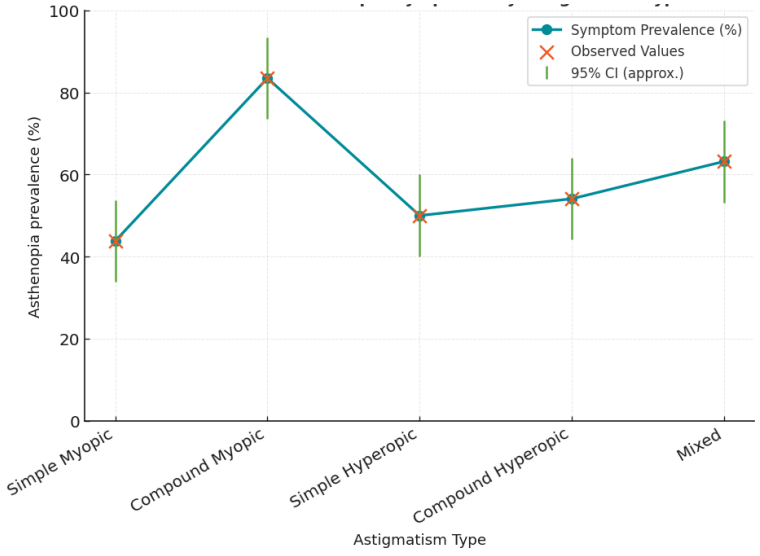

Figure 1 Prevalence of Asthenopia Symptoms by Astigmatism Type

Statistical testing demonstrated a significant association between astigmatism type and asthenopia symptoms. Among participants with compound myopic astigmatism, 71 of 85 (83.5%) reported headaches or double vision, compared with only 7 of 16 (43.8%) in the simple myopic group, yielding an odds ratio of 2.6 (95% CI: 1.4–5.0, p = 0.005). Similarly, meridional orientation was significantly associated with asthenopia. With-the-rule astigmatism was linked to symptoms in 62 of 85 cases (72.9%), whereas only 22 of 39 (56.4%) with oblique astigmatism and 34 of 62 (54.8%) with against-the-rule astigmatism reported similar complaints. The odds of symptomatic presentation in with-the-rule astigmatism were 2.4 times higher compared to oblique orientation (95% CI: 1.3–4.6, p = 0.004).

The integrated line–scatter visualization shows that compound myopic astigmatism has the highest prevalence of asthenopia symptoms (83.5%), far exceeding the 43.8% observed in simple myopic cases. Intermediate values were recorded for mixed (63.2%), compound hyperopic (54.1%), and simple hyperopic astigmatism (50.0%). The line illustrates a clear upward trend from simple to compound forms, while scatter markers emphasize observed values. Error bars highlight variability, with compound myopic astigmatism consistently above other subtypes. Clinically, this demonstrates that more complex refractive profiles, particularly compound myopia, confer a markedly elevated risk of symptomatic visual discomfort in young adults, underscoring the importance of targeted correction strategies.

DISCUSSION

The present study demonstrates that compound myopic astigmatism was the most frequent refractive subtype among young adults, accounting for nearly half of the participants, and was strongly associated with symptoms of asthenopia. Specifically, more than 80% of individuals with compound myopic astigmatism reported headaches or double vision, compared with less than 45% of those with simple myopia. This finding is consistent with prior research indicating that compound myopic astigmatism produces greater optical blur across multiple meridians, thereby imposing higher accommodative and fusional demands that contribute to visual fatigue (14). Mixed and compound hyperopic forms were also prevalent, though their associations with asthenopia were less pronounced, suggesting that the degree of cylindrical power and the plane of focal error play a crucial role in symptom generation.

In terms of meridional orientation, with-the-rule astigmatism was the most common type observed in this study, affecting 45.7% of participants, and was significantly associated with asthenopia symptoms. Previous investigations have similarly shown that with-the-rule orientation predominates in younger populations, whereas against-the-rule becomes more common with advancing age (15). Our results extend this knowledge by demonstrating that with-the-rule astigmatism not only occurs more frequently in young adults but is also disproportionately associated with headaches and double vision. One explanation may be that the vertical meridian steepness characteristic of with-the-rule error leads to constant visual strain during horizontal reading and near visual tasks, activities that dominate the daily routine of students and young professionals (16).

The high prevalence of asthenopia in this cohort—63.4% reporting headaches and 58.1% reporting double vision—reinforces the clinical importance of uncorrected astigmatism as a public health concern. Similar findings have been reported in East Asian and European populations, where astigmatism has been shown to correlate strongly with symptoms of eye strain, reduced visual acuity, and decreased quality of life (17,18). Importantly, our data suggest that not all astigmatism types confer equal risk, with compound myopic and with-the-rule subtypes exerting a disproportionate burden. These observations underscore the need for subtype-specific awareness and targeted correction strategies rather than a uniform approach to refractive care.

The findings also align with optical theory and visual ergonomics. Compound astigmatism creates two focal lines, neither of which falls directly on the retina, producing persistent blur that requires constant accommodative effort. This contrasts with simple astigmatism, where one focal line lies on the retina, reducing the demand for compensation. Over time, these differences translate into clinically meaningful variations in symptoms, as reflected in our results. This mechanistic understanding provides biological plausibility to the associations observed in the present study and strengthens the argument for early detection and correction (19).

Despite these important findings, some limitations must be acknowledged. The cross-sectional design prevents causal inference, as it cannot establish whether astigmatism type directly leads to asthenopia or whether unmeasured confounders such as prolonged screen use contribute to both conditions. Furthermore, the sample was restricted to young adults within a single geographic setting, which may limit generalizability to older populations or those in different environments. Another limitation was reliance on self-reported symptoms, which introduces the possibility of reporting bias. Nevertheless, the use of standardized refraction protocols, a relatively large sample size, and the application of statistical adjustments strengthen the validity of the study's conclusions.

From a clinical perspective, these results highlight the importance of incorporating comprehensive refractive assessment into routine eye examinations for young adults, particularly in academic institutions and workplaces where visual demands are high. Corrective interventions such as toric contact lenses, customized spectacles, and, in selected cases, refractive surgery may reduce the risk of asthenopia and improve overall visual comfort. Public health initiatives promoting regular vision screening, especially for populations with heavy near-work demands, could further reduce the burden of undetected compound myopic astigmatism and its associated symptoms.

CONCLUSION

This study identified compound myopic astigmatism as the most prevalent refractive subtype among young adults, with nearly half of participants affected and over four-fifths reporting symptoms of asthenopia. With-the-rule astigmatism was also common and significantly associated with headache and double vision, highlighting that specific subtypes, rather than astigmatism in general, disproportionately contribute to visual discomfort. These findings emphasize the clinical and public health importance of early detection, accurate classification, and timely correction of astigmatism to reduce the burden of asthenopia. Integrating routine screening programs into

academic and occupational health services, alongside public awareness initiatives, may substantially improve visual comfort, productivity, and quality of life in populations at high risk.

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