



# **The Relationship between Visual Discomfort and Academic Performance among Medical Students at King Abdulaziz University, Jeddah, Saudi Arabia**

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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:** Visual discomfort or asthenopia is presented through unpleasant somatic and perceptual symptoms including headaches, fatigue, light sensitivity, blurred text, diplopia, movement of letters, and fading and impaired reading performance. Its etiology can be prolonged exposure to near work tasks such as reading or computer use. The American Academy of Ophthalmology, American Association for Pediatric Ophthalmology and Strabismus stated that vision problems could negatively affect learning.

**Objectives:** To measure the prevalence of visual discomfort among the medical students at King Abdulaziz University (KAU) and evaluate its effect on their academic performance.

**Methods:** This cross-sectional study was conducted in 2018 at KAU in the city of Jeddah, Saudi Arabia with 417 medical students. The data were collected using an electronic questionnaire that was sent to their phone numbers. The statistical analyses were done using the statistical package for social sciences (SPSS) software version 21.

**Results:** The visual discomfort symptom scores demonstrated that 87% of the participants scored low, while 12.2% scored moderately; none of the participants scored high. We did not find any significant relationship between visual discomfort and students' cumulative GPA or GPA of the last semester. We noted that the most common visual discomfort symptoms were associated with reading and light sensitivity.

**Conclusion:** This study demonstrated that visual discomfort symptoms did not affect the cumulative or last semester GPA.

*Keywords: Visual discomfort; asthenopia; academic performance.*

## 1. INTRODUCTION

Vision is a sense that perceives visual information through the eyes, to be processed by the brain to elucidate the subject of our sight. However, the visual system has its limits such as the ranges of luminance and wavelengths of light. Therefore, working for extended periods of time in conditions that are close to these limits leads to the onset of signs and symptoms associated with visual discomfort. These symptoms can also be attributed to an imbalance between the elements of vision, including the axial length and the refractive power of the cornea and crystalline lens [1,2]. Visual discomfort or asthenopia are defined as unpleasant somatic and perceptual effects and symptoms [3]. The symptoms include nausea, pain around and in the eyes, headaches, fatigue, light sensitivity, blurred text, diplopia, and moving and fading textual letters, along with impaired reading performance, while the signs include red, itching, or watering eyes [2]. Prolonged near work tasks which involve the eye lens, including reading and computer use, cause symptoms of visual discomfort that are typically prevalent among college students [4]. A study demonstrated that the prevalence of computer use among medical students is significantly high and that 40%-60% of researches done among computer users report visual discomfort [3,5]. Repetitive lines in books form a pattern of stripes that induces visual discomfort in students [6,7]. Another aspect is the veiling reflex which is the reflection light produced by glossy objects such as a glossy book; this reflex can often induce visual discomfort [2]. Problems associated with vision can negatively impact the learning process as stated by the American Academy of Ophthalmology and American Association for Pediatric Ophthalmology and Strabismus [1]. One of the problems that can cause academic difficulties in the classroom is visual discomfort [8].

A previous study demonstrated that an individual with visual impairment can end up fatigued more

rapidly or potentially have more trouble concentrating on a given task compared to those without visual impairment and that any deficit in reading, writing, and spelling will negatively influence the academic development [1].

A study conducted by the Oklahoma College of Optometry among the third, sixth, and seventh grade school students on the association between vision-related quality-of-life factors and academic performance reported that visual symptoms were correlated to academic performance inversely; the lower the academic score, the more symptoms were reported [8].

The literature on optometry, medicine, and education shows that visual function is related to learning. Oculomotor, accommodative, binocular, and visual perceptual dysfunctions are some of the risk factors that lead to lower academic performance [8].

Furthermore, a large sample of under-graduate students, more than 40% of whom had symptoms of visual discomfort, participated in a study, and a significant correlation between visual discomfort and cumulative GPA was found [9].

No previous studies were conducted among the medical students at King Abdulaziz University (KAU) to assess the prevalence of visual discomfort and its relationship with academic performance.

In this study, we aimed to measure the prevalence of visual discomfort among medical student at KAU and its effect on their academic performance.

## 2. METHODS

Four hundred and seventeen medical students aging 18-24 years at KAU in the city of Jeddah , Saudi Arabia were included in the study which was conducted in 2018. Those who refused to participate, did not respond to the electronic questionnaire and with wrong phone numbers

were excluded. All participants agreed to fill out an online questionnaire in a Google Drive form sent to their phone numbers. The questionnaire included 5 sections: personal data, academic information, ophthalmological condition, visual discomfort symptoms (Conlon et al. survey), and the effect of ophthalmological condition on the academic performance. The validated survey, which was developed by Conlon et al., consisted of 23 items with a four-point scale: 0 = never, 1 = occasionally, a couple of times a year, 2 = often, every few weeks, and 3 = almost always. The scores were used to classify the groups as follows: the low discomfort group scored from 0 to 24, the moderate group scored from 25 to 48, and the high group scored from 49 to 69. The statistical analyses were done using the statistical package for social sciences (SPSS) software version 21, using frequency, chi-square test, and one-way ANOVA test; and P-value  $\leq$  0.05 was considered significant.

### 3. RESULTS

We aimed to measure the prevalence of visual discomfort among the medical students at King Abdulaziz University (KAU) and its effect on their academic performance. The results of this cross-sectional study were drawn by analyzing the responses from 417 medical students. This study included 243 women (57.6%) and 174 men (41.2%). The data were collected from June 27 to July 3, 2018. The academic information is summarized in Table 1.

Our results demonstrated that refractive errors were some of the most common ophthalmological conditions as reported by 45.1% of the students, with myopia being the most prevalent form of error (59%); furthermore, dry eyes constituted 22.5% of these conditions. Fig. 1 represents the refractive errors frequency.

The relationship between the visual discomfort symptom score and refractive errors was evaluated using the chi-square test, and the results showed a P-value of .09 which was considered as statistically non-significant. Alternatively, there was a significant relationship between both refractive errors and wearing eyeglasses and refractive errors and wearing contact lenses (P-value = .000). Another significant association was noted between visual discomfort and dry eye with a P-value of .000

Only 29 students (7%) stated that they underwent a laser procedure to treat the refractive errors. A significantly positive relationship was observed between the outcomes of the laser procedure and visual discomfort score (P-value = .02).

The analysis of visual discomfort symptom score demonstrated that 87% scored low and 12.2% scored moderate, while none scored high.

The analysis of the Conlon et al. questionnaire revealed 5 questions that scored the highest percentages with regard to the answer (almost always). A total of 7.2 % of the students tended to use a pencil or finger to keep them from losing place when reading a text, 5.3% complained of headaches, and 5% had to continually move the page around to see the words clearly because of the glare from the bright white glossy pages while working under fluorescent lights. Furthermore, 3.4% and 2.9% of the students unintentionally re-read the same words and lines, respectively. Another important finding was that 2.4% of the students almost always found that reading was a slow task due to their visual problems. Table 2 demonstrates the participants' responses to the Conlon et al. questionnaire.

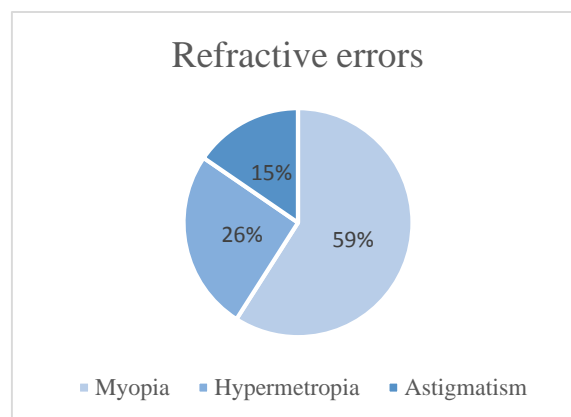


Fig. 1. Refractive Errors Frequency

**Table 1. Academic information**

<b>Academic Information</b>	<b>Frequency</b>	<b>percent</b>
<b>Academic Year</b>		
2 <sup>nd</sup> year	55	13%
3 <sup>rd</sup> year	95	22.5%
4 <sup>th</sup> year	78	18.5%
5 <sup>th</sup> year	111	26.3%
6 <sup>th</sup> year	78	18.5%
<b>The material used while studying</b>		
Paper-based	41	9.8%
Electronic materials	108	25.9%
Both	268	64.3%
<b>Studying hours</b>		
Less than 3	167	40%
3-6	210	50.4%
More than 6	40	9.6%
<b>Last semester GPA</b>		
Mean	4.325	
Standard deviation	0.490	
<b>Cumulative GPA</b>		
Mean	4.341	
Standard deviation	0.436	

The relationship between the visual discomfort score and the materials used by the students while studying was statistically non-significant (chi square = 1.218, P = .54); however, there

was a significant correlation between the visual discomfort score and the number of hours the students spent studying (chi square = 8.309, P = .016).

**Table 2. The Participants' Responses to the Conlon et al. Questionnaire**

	<b>Never</b>	<b>Occasionally</b>	<b>Often</b>	<b>Almost always</b>
1-When reading, do the words or letters in the words ever appear to spread apart?	291	85	35	6
2-Do you ever have difficulty reading the words on a page because they begin to flicker or shimmer?	277	107	30	3
3-Does the white background behind the text ever appear to move, flicker, or shimmer making the letters hard to read?	291	93	27	6
4-Do you ever have difficulty seeing more than one or two words on a line in focus?	318	71	24	4
5-When reading, do the words on the page ever begin to move or float?	329	66	16	6
6-When you are reading a page that consists of black print on white background, does the background ever appear to overtake the letters making them hard to read?	310	73	30	4
7-When reading, do the words on a page of clear text ever appear to fade into the background then reappear?	333	63	16	5

8-Do the letters on a page ever appear as a double image when you are reading?	297	92	24	4
9-When reading black print on a white background, do you ever have to move the page around or continually blink to avoid glare which seems to come from the background?	286	92	33	6
10-Do you ever get a headache from reading a newspaper or magazine with clear print	245	128	36	8
11-Do you have to move your eyes around the page, or continually blink or rub your eyes to keep the text easy to see when you are reading?	196	156	52	13
12-When reading do you ever have to squint to keep the words on a page of clear text from going blurry or out of focus?	277	95	36	9
13-Do the letters on a page of clear text ever go blurry when you are reading?	246	136	30	5
14-When reading, do you ever have difficulty keeping the words on the page of clear text in focus?	284	105	23	5
15-Do your eyes ever feel watery, red, sore, strained, tired, dry or gritty, after you have been reading a newspaper or magazine with clear print?	246	126	36	9
16-Do your eyes ever feel watery, red, sore, strained, tired, dry, gritty, or do you rub them a lot, when viewing a striped pattern?	267	109	35	6
17-Do you have to use a pencil or your finger to keep from losing your place when reading a page of text in a novel or magazine?	152	150	85	30
18-How often do you get a headache when working under fluorescent lights?	174	169	52	22
19-Do your eyes ever feel watery, red, sore, strained, tired, dry or gritty, when working under fluorescent lights?	226	129	53	9
20-When reading under fluorescent lights or in bright sunlight, does the glare from the bright white glossy pages cause you to continually move the page around so that you can see the words clearly?	223	113	60	21
21-When reading, do you ever unintentionally re- read the same words in a line of text?	128	181	94	14
22-When reading do you ever unintentionally re- read the same line?	114	190	101	12
23-As a result of any of the above difficulties, do you find reading a slow task?	216	147	44	10

**Table 3. Visual Discomfort Score and Students' Thoughts**

Visual discomfort symptoms	Do you think your academic performance is affected by your ophthalmological condition?		
	no	yes	maybe
low	60.9%	13.4%	25.7%
Moderate	25.5%	25.5%	49%
Total	56.6%	14.9%	28.5%

The chi-square test was used to assess the relationship between the visual discomfort symptom score and 14.9% of the students who thought that their academic performance was affected by their ophthalmological condition; the results indicated a significant association with a value of 22.885 (P-value = .000). Table 3 shows the different percentages of visual discomfort score in relation to the students' thoughts.

A non-significant relationship was found between the visual discomfort score and GPA of the last semester (P-value = .80), as well as with cumulative GPA (P-value = .18).

#### 4. DISCUSSION

This cross-sectional study assessed the impact of visual discomfort on academic performance among the medical students at King Abdulaziz University (KAU).

The results of the present study revealed that the relationship between visual discomfort and the students' cumulative GPA and GPA of the last semester is non-significant. Alternatively, a study done by Oklahoma College of Optometry among school students reported that visual symptoms are inversely correlated with academic performance [8]. Another study conducted on southern Brazil school students recommended health professionals to be watchful for the complaints of visual fatigue considering its capability to affect learning and school activities [10]. Other studies confirmed that asthenopia might interfere with attention and academic performance [11-13]. A possible explanation for this finding could be the differences in symptom perception; the students' adaptation to the symptom made them consider it a normal situation. Another reason could be the sample size and differences in the study population. Most studies mentioned above were done among school children in whom the different aspects of vision were still developing; therefore, any visual problems would have had a greater impact on the youngest individuals.

Furthermore, a significant correlation existed between those who believed their academic performance to be affected by their ophthalmological condition and the visual discomfort score. In a study done using college students as participants, 69% of those who scored high reported that their symptoms affected their grades compared to the 15% who demonstrated a low visual discomfort score. The severity of visual symptoms was directly associated with a greater number of reported academic problems [14].

In the current study, a significant association between visual discomfort symptoms and studying hours was found. Parallely, a comprehensive quantitative study demonstrated that the prolongation of reading behavior itself was considered to be the most direct cause of visual fatigue. A significant degree of change was noted after spending 6 continuous hours reading, making it an increasingly unpleasant task [15]. Furthermore, the visual discomfort symptoms were investigated among college students, and it had been reported that 60% of the individuals with moderate to severe symptoms felt discomfort within half an hour of reading and 30% within 15 minutes. These symptoms had an adverse effect on the academic performance [14].

Although we noted that the correlation between the visual discomfort score and the study material was relatively non-significant, students who used electronic study materials while studying scored moderately (27.5%) compared to those who used paper-based materials (13.7%); these results were consistent with those of other studies. The Ohio State University, College of Optometry reported that participants that read under the following conditions demonstrated symptoms of asthenopia: glare, flickering light, and small font size [16]. Another study on prolonged reading from computer and papers found that reading among computer users was slower, less accurate, and more fatiguing, with decreased comprehension. Sample size differences could clarify the non-significant relationship [17].

According to the results of this study, the highest frequency of visual discomfort symptoms was on using a pencil or finger while reading a text, re-reading the same words and lines, and getting headaches when working under a fluorescent light; therefore, these appear to be the most common complaints that include reading and light-associated issues. Similarly, a study performed among Claremont College students using the Conlon et al. questionnaire reported that the most common complaints involve reading problems and light sensitivity [14].

In this study, the prevalence of refractive errors was 45.1%, with myopia having the highest prevalence (59%); furthermore, studies done among medical students in Nepal, Singapore, and Taiwan diagnosed them to have refractive errors with myopia scoring 64.81%, 89.6%, and 92.8%, respectively [18,19]. All studies agreed that myopia is the most common form of refractive error among medical students, the increasing rates of myopia among medical students could be due to near work tasks and computer use [20]. The non-significant relationship between the visual discomfort symptoms and refractive errors in the present study could be because 86.2% of the students in this study wore eyeglasses and 22.5% wore contact lenses; therefore, correcting the refractive errors lead to a decrease in the visual discomfort symptoms.

Other ways to correct refractive errors include photorefractive keratectomy (PRK) and laser in-situ keratomileusis (LASIK), but these 2 procedures are known to cause dry eye. Yu and colleagues found that a high percentage of patients who underwent LASIK procedure complained of dry eye [21]. Additionally, a study done by Stephenson and colleagues showed that the incidences of dry eye symptoms were similar in post-PRK and post-LASIK, but they appeared to be more prominent in the hyperacute post-operative period [22].

The significant relationship between the visual discomfort score and dry eye was in line with the findings of a study done at Acta Ophthalmologica Scandinavica Institution that suggested a strong relationship between visual fatigue and dry eye [23]. The Women's Health Study and Physicians' Health Study found that daily activities, such as reading, studying using the computer, and doing their work activities were limited by the symptoms of dry eye [24]. These symptoms can be experienced by medical students and

negatively affect their academic performance, but this can pass unnoticed with the high probability of medical students using self-prescribed tear substitution drops.

This study enrolled 417 medical students from KAU. Since the data collection was done using an electronically based questionnaire that was sent to the participants' phone numbers, there were several limitations that included a refusal to participate, wrong phone numbers, unresponsiveness to the questionnaire, and the inability to contact some of the KAU medical students. The data gap was another challenging limitation during the literature review.

On investigating the effect of visual discomfort on the academic performance of medical students at King Abdulaziz University (KAU), this study demonstrated that visual discomfort symptoms had no significant impact on the cumulative GPA or the GPA of the last semester. Considering the lack of research investigating visual discomfort and its impact, further research is required in this regard.

## 5. CONCLUSION

This study demonstrated that visual discomfort symptoms are considered a bothering issue among medical students, but it did not significantly affect their cumulative or last semester GPA. We recommend future researchers to look more into participants' eye diseases, chronic illnesses or comorbidities that might be associated to asthenopia or affect their vision.

## CONSENT

As per international standard or university standard, participants' electronic consent has been collected and preserved by the author(s).

## ETHICAL APPROVAL

This analytical cross-sectional study was approved by the institutional review board (IRB) of Biomedical Ethics at King Abdulaziz University (KAU) (Ref: 35518).

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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