ORIGINAL RESEARCH

A Study To Evaluate Association Of Symptoms Of Asthenopia With Refractive Errors And Other Causes Of Asthenopia – A Clinical Based Observational Study

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ABSTRACT
Prolonged use of computers and digital devices has becomesucha common cause of asthenopia. The decrease in asthenopia and morbidities associated with it among students(6-25 years of age) can lead to an important benefit to promote next generation of their career and health, both intellectually and psychologically, since these are the formative years in life, hence, justifying the need for research in this area. **Material and Methods:** The present study was carried among 750 children who and were diagnosed with asthenopia. Patients were tested for various refractive errors and the best corrected visual acuity(BCVA) was recorded. Retinoscopy was done using a streak retinoscope and orientation of Streak for astigmatism was done. Various associated symptoms and other parameters were evaluated using Chi square P value <0.05 was considered as statistically significant. **Results:** Eye strain was noted in significantly higher proportions of eyes with myopia and astigmatism as compared to emmetropia and hyperopia (p<0.05) where as blurred vision was noted insignificantly higher proportions of eyes with hypermetropia(p<0.05). Dryness, irritation and sore eyes were present insignificantly higher proportions of emmetropic eyes (p<0.05). Low grades of myopia, low grade of hypermetropia and compound myopic astigmatism followed by simple myopic astigmatism were associated with more number of symptoms. Prolongedduration of digitaldevice/computer us age was significantly as sociated with higher number of symptoms associated with asthenopia (p<0.05). **Conclusion:** Compound myopic astigmatism was more commonly as sociated with asthenopic symptoms, followed by low my opia and low hypermetropia respectively. Our study focused on the school and college going age group as they are over burdened with constant near work. And with the increase in online classes, digitalisation and work from home culture, it is the need of the hour to focus on treating the cause of asthenopia as it can lead to an important benefit to promote next generation of their career and health, both intellectually and psychologically.
Keywords: Asthenopia; Digitalisation; Eye strain

INTRODUCTION
Prolonged use of computers and digital devices has become such a common cause of asthenopia that it has been dubbed "computer vision syndrome" or "digital eyestrain."[1]Asthenopia is a common eye complaint and can interfere with learning, office work. Ithas become a significant public health problem. With the change of lifestyle and the spread of personal computers, increasing rates of such complaints have been reported. Asthenopic symptoms are less frequent at distance vision than at near vision, because there is less strain on the accommodation and vergence systems. Asthenopic symptoms are becoming more common in modern society where near work at computers require sustained fixation, often for hours, at the same visual distance, which puts a strain on the system for near vision.[2]Asthenopia mostly occurs due to uncorrected refractive errors,[3] accommodative dysfunctions,[4,5] vergence anomalies,[6,7] inappropriate lighting condition,[8] extraocular muscle imbalance,[9] and compromised quality of the viewed image such as poor contrast.[10] These asthenopia symptoms can be severe enough to limit personal activities and further result in

potentially speeding up the development of age-related eye diseases. Therefore, identifying risk factors of asthenopia is of great importance to improve visual function and decrease the risk of visual fatigue. Refractive errors are treatable yet highly undetected cause of asthenopia. Studies purely dealing with asthenopic symptoms related to refractive errors are limited. Moreover, until recently little information is available regarding the asthenopia with risk factors among children and college students. The decrease in asthenopia and morbidities associated with it among students(6-25 years of age) can lead to an important benefit to promote next generation of their career and health, both intellectually and psychologically, since these are the formative years in life, hence, justifying the need for research in this area.

MATERIAL AND METHODS

The present study was carried among 750 children who reported to the Ophthalmology department, People's College of Medical Science & Research Centre, Bhopal and were diagnosed with asthenopia. The inclusion criteria consisted of individuals 6-25 years presenting in Ophthalmology out patient department with symptoms of asthenopia. Asthenopia was defined as presence of at least one of the ten symptoms of eye pain, dry eyes, eye swelling, blurred vision, diplopia, foreign body sensation, photophobia, tearing, decreased visual acuity, and difficulty in sustaining visual activities. Exclusion criteria comprised of post traumatic patients, post-surgical cases, congenital and developmental anomalies, history of migraine, strabismus, ocular or systemic diseases affecting binocular vision, patient not willing to participate. A written informed consent was taken from the parents (<18 years) and students (19-25years) for inclusion into the study. Baseline demographic data was collected in Proforma. Patients were tested for non-cycloplegic auto-refraction, uncorrected visual acuity(UCVA), auto-refraction results were refined through trial lenses.. For any case with UCVA worse than 6/9 in either eye, subjective refraction was done and the best corrected visual acuity(BCVA) was recorded. Retinoscopy was done using a streak retinoscope and orientation of Streak for astigmatism was done. The clinician was seated in front of the patient by a short distance of 40 cm. The room was well lighted to promote visual inspection of thee ys. The cover test was performed with the patient wearing his/her habitual optical correction (spectacles or contact lenses) in the early phases of the eye examination. The patient was asked to fixate atargetat distance (an isolated letter above threshold in the poorer eye). Normal individuals should be able to sustain steady fixation for 10seconds or more, monocularly and binocularly, which is sufficient to conduct the cover test. The eyes howing heterophoria(or merely "phoria") will move to take up fixation after the occlusion is ended unless the eyes have zero phoria (orthophoria). If movement of either or both of the fixating eyes is detected immediately after removal of the contralateral occlusion, strabismus("tropia") may be present. The alternating cover test was used to confirm the direction and to measure the magnitude of a phoria ortropia. The AC/A ratio was determined by heterophoria method. Ocular deviation was measured with full optical correction at 6m and 33 cm distance in prism dioptres. IPD was measured in cm. Then AC/A ratio was calculated using following formula:

AC/A=IPD+ Δn -$\Delta d/d$,where:

IPD=interpupillary distance

Δn=deviation at33 cm 9(or3 D distancein prism diopters)

Δd=deviation at 6m distance

d=fixation distance atnearinprism dioptres

Esode viation were de noted by positive(+)and exodeviation were de not ed by negative(-)signs.

Schirmers test was doneto rule out dry eye disease. This was followed by Slit lamp examination and fundus examination by direct ophthalmos copy followed by in direct ophthalmos copy with 20D lens and 90 Dlens.

The data will be compiled and analysed using suitable statistical software. Various associated symptoms and other parameters were evaluated using Chi square P value <0.05 was considered as statistically significant.

RESULTS

Table1: Distribution according to uncorrected visual cuity

Uncorrected Visual acuity	Frequency(n=1500)	Percentage
6/6-6/12	1001	66.7
6/18-6/60	354	23.6
<6/60-3/60	119	7.9
<3/60 to 1/60	24	1.6
CFor less	2	0.13

Visual acuity was in the range of 6/6to6/12 in majority of cases, 66.7%. Visual acuity of less than 3/60 was noted in 1.7% cases (table 1).

Table2: Distribution according to best corrected visual acuity

BCVA	Frequency(n=1500)	Percentage
6/6-6/12	1410	94
6/18-6/60	73	4.87

<6/60-3/60	11	0.73
<3/60 to 1/60	4	0.27
CFor less	2	0.13

Majority of cases had normal visual acuity i.e.6/6to6/12 in 94% cases. Visual acuity of less than 3/60 was observed in 0.4%cases (table 2).

Table3: Distribution according to finding of cover test

Cover test	Frequency(n=750)	Percentage
Orthophoria	692	92.3
Heterophoria	58	7.7

Cover test revealed orthophoria in92.3% eyes where as heterophoria was noted in 7.7% cases in our study (table 3).

Table4: Near point convergence in patients with asthenopia

Near point convergence	Frequency(n=750)	Percentage
Normal(<8)	621	82.8
Insufficiency(>8)	129	17.2

Mean near point convergence was 0.6±0.25 and convergence insufficiency was noted in 17.2% cases in our study (table 4).

Table5: Distribution according to AC/A ratio

AC/A ratio	Frequency(n=750)	Percentage
Low	3	0.4
Normal	685	91.3
High	62	8.3

Mean AC/A ratio was 4.4±0.8 and AC/A ratio was normal in 91.3% cases. Ac/A ratio was high in 8.3% and low in 0.4% cases with asthenopia (table 5).

Table 6: Association of symptoms with refractive errors

Symptoms	Emmetropia	Myopia	Astigmatism	Hyperopia	x^2	P value
Heavy eyes	24(9.4%)	41(13.9)	125(13.5%)	4(16%)	3.5	0.32
Sore eye/eye ache	59(23.1)	41(13.9)	144(15.6)	4(16)	**10.2**	**0.02**
Irritation	56 (22)	40(13.6)	192(20.8)	4(16)	**8.7**	**0.03**
Watering	91(35.7)	93(31.5)	276(29.8)	6(24)	3.8	0.28
Dryness	55(21.6)	49(16.6)	180(19.5)	0 (0)	**8.2**	**0.04**
Burning sensation	21(8.2)	32(10.8)	85(9.2)	0 (0)	3.78	0.29
Eyestrain	38(14.9)	68(23.1)	198(21.4)	2 (8)	**8.97**	**0.03**
Blurred vison	64(25.1)	98(33.2)	333(36)	11(44)	**11.85**	**0.008**
Difficulty in focusing	15(5.9)	37(12.5)	98(10.6)	0 (0)	11.7	0.07
Visual discomfort	16(6.3)	24(8.1)	110(11.9)	2 (8)	**8.73**	**0.03**
Headache	112(43.9)	165 (55.9)	415(44.9)	11(44)	0.11	0.99

In our study, eye strain was noted in significantly higher proportions of eyes with myopia and astigmatism as compared to emmetropia and hyperopia (p<0.05) where as blurred vision was noted insignificantly higher proportions of eyes with hypermetropia(p<0.05). Dryness, irritation and sore eyes were present insignificantly higher proportions of emmetropic eyes (p<0.05) (table 6).

Table 7: Association of symptoms with gender

Symptoms	Male	Female	x^2	P value
Heavy eyes	35(11.5)	62(13.9)	0.97	0.33
Sore eye/eye ache	52(17)	72(16.2)	0.09	0.75
Irritation	54(17.7)	92(20.7)	1.02	0.31
Watering	86(28.2)	147(33)	1.98	0.16
Dryness	59(19.3)	83(18.7)	0.06	0.81
Burning sensation	24(7.9)	45(10.1)	1.09	0.29
Eye train	65(21.3)	88(19.8)	0.26	0.61
Blurred vison	111(36.4)	142(31.9)	1.63	0.20
Difficulty in focusing	28(9.2)	47(10.6)	1.08	0.58
Visual discomfort	28(9.2)	48(10.8)	0.518	0.472
Headache	128(42)	206(46.3)	1.37	0.24

The present study documented no significant association of asthenopia symptoms with sex(p>0.05) (table 7).

Table8: Association of sociodemographic variables with number of symptoms

Sociodemographic variables		No. of symptoms				χ^2	P value
		1	2	3	4		
Sex	Male	98(32.1)	180(59)	24(7.9)	3 (1)	3.63	0.30
	Female	115(25.8)	285(64)	39(8.8)	6(1.3)		
Age(years)	6-10	23(51.1)	20(44.4)	2(4.4)	0 (0)	**129.4**	**0.001**
	11-15	16(9.8)	80(49.3)	59(36.4)	6(3.7)		
	16-20	40(16.2)	119(48.3)	84(34.1)	4(1.6)		
	21-25	83(27.9)	195(65.7)	18(6.1)	1(0.3)		

In present study, number of symptoms were higher in significantly higher proportions of patients belonging to 21 to 25 years of age (p<0.05), whereas no such association with sex was observed (p>0.05) (table 8).

Table9: Association of number of symptoms with hours of computer usage

No. of symptoms	Hours of computer usage				
	0	1-2	3-4	5-6	≥7
1	3(60)	45(39.5)	72(25.1)	49(22.9)	44(33.8)
2	2(40)	62(54.4)	190(66.2)	144(67.3)	67(51.5)
3	0 (0)	5(4.4)	24(8.4)	20 (9.3)	14(10.8)
4	0 (0)	2(4.4)	1(0.3)	1(0.5)	5(3.8)
x^2	31.29				
Pvalue	0.002				

Prolonged duration of digital device/computer usage was significantly associated with higher number of symptoms associated with asthenopia (p<0.05) (table 9).

Table10: Association of symptoms of asthenopia with causes of asthenopia

Symptoms	Refractive error	Amblyopia	Heterophoria	Convergence insufficiency	Dry eyes	CVS
Heavy eyes	170(11.3)	14(0.9)	7(0.5)	62(4.1)	8(0.5)	36(2.4)
Sore eye/ Eye ache	189(12.6)	22(1.5)	8(0.5)	60(4)	24(1.6)	20(1.3)
Irritation	236(15.7)	18(1.2)	23(1.5)	116(7.7)	36(2.4)	32(2.1)
Watering	375(25)	42(2.8)	29(1.9)	114(7.6)	24(1.6)	58(3.9)
Dryness	229(15.3)	16(1.1)	11(0.7)	74(4.9)	96(6.4)	28(1.9)
Burning sensation	117(7.8)	6(0.4)	3(0.2)	56(3.7)	18(1.2)	6(0.4)
Eye train	268(17.9)	22(1.5)	15(1)	94(6.3)	20(1.3)	52(3.5)
Blurred vison	442(29.5)	40(2.7)	37(2.5)	110(7.3)	38(2.5)	66(4.4)
Difficulty in focusing	1(0.1)	0 (0)	4(0.3)	60(4)	10(0.7)	34(2.3)
Visual discomfort	136(9.1)	0 (0)	4(0.3)	72(4.8)	10(0.7)	32(2.1)
Headache	556(37.1)	40(2.7)	32(2.1)	246(16.4)	78(5.2)	66(4.4)

Heavy eyes were documented in 11.3% cases and 4.1% cases with convergence insufficiency. In patients with refractive error, 37.1% cases had headache, 29.5% cases had blurred vision, 17.9% cases had eyes train and 15.7% cases had irritation. Headache was noted in 16.4% cases with convergence in sufficiency (table 10).

Table11: Association of number of symptoms with subtypes of refractive errors

Refractive error		No. of symptoms				
		1	2	3	4	5
Myopia	Low	86 (95.6%)	126 (88.1%)	47 (88.7%)	8 (100%)	1 (100%)
	Moderate	4 (4.4%)	10 (7.0%)	6 (11.3%)	0 (0%)	0(0%)
	High	0 (0%)	7 (4.9%)	0 (0%)	0 (0%)	0 (0%)
Astigmatism	Simple myopic	88 (44.4%)	174 (32.5%)	55 (35.3%)	9 (25.7%)	1 (100%)
	Simplehypermetropic	2 (1%)	4 (0.7%)	4 (2.6%)	2 (5.7%)	0 (0%)
	Compound myopic	99 (50.0%)	349 (65.2%)	92 (59%)	24 (68.6%)	0 (0%)

	Compound hypermetropic	4 (2%)	6 (1.1%)	4 (2.6%)	0 (0%)	0 (0%)
	mixed	5 (2.5%)	2 (0.4%)	1 (0.6%)	0 (0%)	0 (0%)
Hypermetropia	Low	10 (76.9%)	7 (87.5%)	2 (50%)	0 (0%)	0 (0%)
	Moderate	3 (23.1%)	1 (12.5%)	1 (25%)	0 (0%)	0 (0%)
	high	0(0%)	0(0%)	1(25%)	0(0%)	0(0%)

Low grades of myopia, low grade of hypermetropia and compound my opicastigmatism followed by simple my opicastigmatism were associated with more number of symptoms (table 11).

DISCUSSION

Asthenopia, also called eyes train or ocular fatigue is a term used to describe symptoms arising from the intense use of eyes.[1] It is a subjective condition characterized by wide range of non specific as well as specific symptoms due to excessive use of eye and ocular fatigue.[1,2] Asthenopia have been attributed to multiple underlying causes such as uncorrected refractive errors, convergence and accommodative dysfunctions, prolonged use of digital device, imbalance of extra-ocular muscles, inappropriate light condition and poor contrast.[3-10] The prevalence of asthenopia is increasing globally due to increase in the use of digital devices, requiring sustained fixation of eyes.[1]

Ocular examination of all the study participants was done in detail in our study. Uncorrected visual acuity and best corrected visual acuity were recorded in all the study participants. Uncorrected visual acuity ranged between 6/6to6/12 in majority of cases, uncorrected visual acuity less than 3/60 was reported in 1.7% cases. Following correction, best corrected visual acuity between 6/60 to 3/60 was noted in 0.73%whereas that of <3/60 was noted in 0.4%. Apart from vision test, cover test, NPC and AC/A ratio were assessed. We reported heterophoria in 7.7% cases whereas NPC insufficiency was noted in 17.2% and AC/A ratio was high in 8.3% whereas it was low in 0.4% cases with asthenopia. Similarly, mean A A and NPC were significantly higher in asthenopia cases as compared to non asthenopic cases (P < 0.05) in a study of Has hemi Hetal(2019)[11] and on multivariate analysis found NPC as independent factor associated with asthenopia. Vilela MA et al (2015) [12] also reported visual acuity of 20/25 or better in both the eyes in majority i.e., 92.8% cases whereas abnormality in near point of convergence and altered AC/A ratio was documented in 14% and 17.1% cases respectively. Wajuihian S et al(2015)[13] reported unaided VA of 6/9 or worse in 22.5% cases whereas about 3.1% children had visual impairment after correction. However, in a study of Abdi S et al (2005),[14] the authors included 120 children and uncorrected visual acuity of 0.8 to 1 was reported in 95students, cover Test at distance revealed orthophoria in 111 students whereas cover test at near revealed exophoria in 55students. The authors also reported convergence insufficiency in 22 students. In our study, we assessed the association of asthenopic symptoms with refractive errors and other causes of asthenopia. We reported eye strain to be significantly associated with myopia and astigmatism whereas blurred vision was found to be significantly associated with hypermetropia (p<0.05). However, dryness, irritation and sore eyes were found to be associated with mmetropia(p<0.05). Heavy eyes and headache were documented in higher proportions of cases with convergence insufficiency whereas 37.1% % cases with refractive errors had headache and 29.5% cases had blurred vision. We reported prolonged use of digital device to be significantly associated with higher number of symptoms (p<0.05). Our study findings were supported by the findings of Dhungel Detal(2017),[15] in which dry eye and blurred vision were documented to be significantly higher in patients of asthenopia due to refractive error as compared to control group (p>0.05) whereas severity of watering was found to be higher in control groups as compared to refractive error group (p<0.05). Sore/aching eye, blurred vision and dryness were found to significantly associated with astigmatism, whereas myopia was associated with general visual discomfort(p<0.05). Afzal F et al(2019)[16] documented headache and blurring to be significantly associated with myopia whereas double vision was associated with hypermetropia as well asanisometropia(p<0.05). Similarly, Prabhu P B et al(2016) [17] reported eye pain and itching insignificantly higher proportions of cases with hypermetropia whereas watering and diplopia was noted insignificantly higher proportions of cases with astigmatism. Our study findings were also supported by the findings of Wajuihian S et al (2017), [18] in which mean symptom scores were significantly higher for convergence excess, pseudo-convergence insufficiency, and fusion alvergence dysfunction

Though were ported no significant difference in individual symptoms as well as number of symptoms between males and females (p>0.05), however, we reported significantly higher number of symptoms among students belonging to 21 to 25years of age(p<0.05). Wajuihian S et al(2015) [13] reported significantly higher frequency of symptoms in students of high school as compared to primary school (p<0.05), similar to our study whereas the frequency of symptoms particularly, headache, photophobia as well as redness were documented in significantly

higher proportions of females(p<0.05). Dhungdel D et al (2017) [15] documented significantly higher rate of tired eyes and sore eyes in females in control group and double vision in refractive error group (p<0.05); also blurred vision was noted in significantly higher proportions of cases belonging to age range of 21–25 years ($p < 0.05$) and among males ($p < 0.01$). Wajuihian S et al(2017)[18] also reported significantly higher mean symptoms score in females and older students as compared to males and younger individuals respectively(p<0.05).

CONCLUSION

Compound myopic astigmatism was more commonly associated with asthenopic symptoms, followed by low myopia and low hypermetropia respectively. Prolonged duration of digital device/computer usage was significantly associated with higher number of symptoms associated with asthenopia (p<0.05) Our study focused on the school and college going age group as they are over burdened with constant near work. And with the increase in online classes, digitalisation and work from home culture, it is the need of the hour to focus on treating the cause of asthenopia as it can lead to an important benefit to promote next generation of theircareer and health, both intellectually and psychologically.

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