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Original Article

Assessment of Binocular Vision and Digital Device Use in Asthenopic and Non-Asthenopic Pre-Presbyopic Adults

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ABSTRACT

Background: Digital device use has increased substantially among pre-presbyopic adults and is frequently associated with asthenopic symptoms such as eye strain, headache, blurred vision, diplopia, ocular fatigue, and burning sensation. However, the relationship between these symptoms and measurable binocular vision parameters remains unclear. **Objective:** To assess binocular vision parameters and digital device-use patterns among asthenopic and non-asthenopic pre-presbyopic adults and determine whether asthenopic symptoms are associated with objective binocular vision differences. **Methods:** An analytical cross-sectional comparative study was conducted among 70 adults aged 20–40 years who were regular digital device users. Participants were classified as asthenopic or non-asthenopic using the Convergence Insufficiency Symptom Survey. Digital device-use characteristics and asthenopic symptoms were recorded through a structured questionnaire. Binocular vision assessment included near point of convergence, positive and negative fusional vergence, accommodative amplitude, accommodative facility, and vergence facility. Data were analyzed using SPSS version 26.0, with independent-samples t-tests used for group comparisons. **Results:** Asthenopia was present in 44 participants (62.9%), while 26 participants (37.1%) were non-asthenopic. Eye strain and headache were the most common symptoms, each reported by 39 participants (55.7%). More than one-third of participants used digital devices for >8 hours daily, and 37 participants (52.9%) reported worsening symptoms after prolonged device use. No statistically significant differences were found between asthenopic and non-asthenopic groups for near point of convergence, positive or negative fusional vergence, accommodative amplitude, accommodative facility, or vergence facility. **Conclusion:** Asthenopia was highly prevalent among pre-presbyopic digital device users, but symptoms were not associated with significant differences in measured binocular vision parameters. Digital eye strain appears to be multifactorial, requiring assessment of binocular function alongside screen exposure, visual breaks, ergonomics, and ocular comfort. **Keywords:** Asthenopia; Digital Eye Strain; Binocular Vision; Convergence Insufficiency Symptom Survey; Screen Time; Pre-Presbyopic Adults.

INTRODUCTION

Digital device use has become an integral part of education, occupational work, communication, and recreation, particularly among young and middle-aged adults who perform prolonged near tasks on smartphones, tablets, laptops, and desktop computers. Unlike printed material, digital screens are self-illuminated, frequently viewed at variable and often shorter working distances, and commonly used for uninterrupted periods, thereby increasing accommodative demand, convergence load, and visual attention. These visual demands may contribute to asthenopia, a symptom complex characterized by eye strain, headache, blurred vision, diplopia, ocular fatigue, burning sensation, dryness, and difficulty sustaining near work (1). The clinical relevance of this problem is increasing because digital eye strain is now reported across students, office workers, and other visually demanding populations, with prevalence estimates varying widely according to exposure duration, diagnostic criteria, and population characteristics (2).

Pre-presbyopic adults represent an important population for investigating digital-device-related asthenopia because accommodative function is generally expected to remain active and clinically efficient before the onset of presbyopia. In this age group, persistent near-work symptoms are less likely to be explained by age-related accommodative loss alone and may instead reflect functional visual stress, binocular inefficiency, ocular surface disturbance, suboptimal ergonomics, or behavioral exposure patterns. Sustained screen use may reduce blink rate, destabilize the tear film, increase ocular surface discomfort, and impose continuous accommodative and vergence effort, especially when devices are held at close viewing distances or used without regular visual breaks (3,4). Consequently, patients may report substantial symptoms despite having normal visual acuity, no major refractive error, and no obvious ocular pathology on routine examination.

Efficient near vision depends on coordinated interaction between accommodation, convergence, fusional vergence, ocular alignment, and visual comfort. Binocular vision parameters such as near point of convergence, phoria status, positive and negative fusional vergence, accommodative amplitude, accommodative facility, and vergence facility provide objective information about the functional capacity of the visual system during near tasks. Abnormalities in these parameters may contribute to symptoms such as headache, diplopia, blurred vision, and reduced reading endurance, yet the relationship between subjective asthenopic symptoms and measurable binocular dysfunction is not always consistent. Some individuals with symptoms may show clinically normal binocular vision findings, whereas others with measurable binocular anomalies may remain relatively asymptomatic (5,6). This mismatch creates a diagnostic challenge and supports the need to evaluate both symptom burden and objective visual function in the same population.

The Convergence Insufficiency Symptom Survey is commonly used to quantify symptoms related to near-vision discomfort, including eye strain, headache, blurred vision, diplopia, loss of concentration, and difficulty completing near tasks. When combined with objective binocular vision testing, symptom-based classification allows comparison between individuals with and without clinically relevant asthenopic complaints. Previous studies have reported that prolonged digital device exposure may influence accommodation and vergence responses, but the magnitude and clinical detectability of these changes vary across populations and testing protocols (7,8). Environmental and behavioral factors, including lighting, glare, posture, viewing distance, screen brightness, total screen time, and lack of visual breaks, may further modify symptom expression and explain why symptoms do not always correspond directly to measurable binocular vision abnormalities (9,10).

Although digital eye strain has been widely discussed, limited local clinical data are available comparing binocular vision parameters between asthenopic and non-asthenopic pre-presbyopic adults who regularly use digital devices. This gap is clinically important because management strategies differ depending on whether symptoms are primarily associated with measurable binocular vision dysfunction or with modifiable behavioral and environmental exposures. If asthenopic symptoms are strongly linked to abnormal binocular parameters, management may prioritize optical correction, vergence therapy, accommodative therapy, or targeted binocular vision intervention. Conversely, if symptoms occur without significant binocular vision differences, counseling on visual hygiene, ergonomic modification, screen-time regulation, blink awareness, and scheduled visual breaks may be equally or more relevant (11,12).

Therefore, the present study was designed to assess binocular vision parameters and digital device-use patterns among asthenopic and non-asthenopic pre-presbyopic adults. Using a cross-sectional comparative approach, adults aged 20–40 years were classified according to asthenopic symptom status and evaluated for near point of convergence, fusional vergence reserves, accommodative amplitude, accommodative facility, and vergence facility. The study aimed to determine whether asthenopic symptoms among digital device users are associated with measurable differences in binocular vision parameters or whether symptoms may occur despite clinically comparable binocular function. The

primary research question was whether pre-presbyopic adults with asthenopia differ significantly from non-asthenopic adults in objective binocular vision parameters during near-vision assessment.

MATERIALS AND METHODS

An analytical cross-sectional comparative study was conducted to evaluate binocular vision parameters and digital device-use patterns among asthenopic and non-asthenopic pre-presbyopic adults. The cross-sectional design was selected because the objective was to assess symptom status, digital device exposure, and binocular vision findings at a single point in time and to compare objective clinical parameters between participants with and without asthenopic symptoms. The study was carried out in a clinical setting at Sheikh Zaid Hospital over a three-month period, where eligible participants were recruited, screened, and examined under standardized clinical conditions.

The study population comprised pre-presbyopic adults aged 20–40 years who were regular users of digital devices. Participants were selected through non-probability convenience sampling based on accessibility, willingness to participate, and fulfillment of eligibility criteria. Individuals were included if they were between 20 and 40 years of age, had best-corrected visual acuity of 6/6 in each eye, had used digital devices for at least three months, and were able to understand and complete the symptom questionnaire. Participants with refractive error exceeding ±5.00 diopters sphere or ±2.00 diopters cylinder were not included. Individuals were excluded if they had diagnosed presbyopia, age-related accommodative insufficiency, history of strabismus, amblyopia, previous binocular vision therapy, active ocular disease including keratitis, glaucoma, or retinal pathology, previous ocular surgery, ocular trauma within the preceding six months, neurological disease affecting vision, or use of medications known to influence accommodation or vergence function.

A total of 70 eligible participants were enrolled. Before data collection, informed consent was obtained from each participant, and a unique identification code was assigned to maintain confidentiality. Data were collected using a structured questionnaire and clinical binocular vision assessment. The questionnaire recorded demographic characteristics and digital device-use variables, including the type of device most frequently used, duration of daily screen exposure, usual viewing distance, total duration of digital device use, use of visual breaks, and whether symptoms increased after prolonged screen exposure. Asthenopic symptoms were assessed using the Convergence Insufficiency Symptom Survey, which included symptoms such as eye strain, headache, blurred vision, double vision, ocular fatigue, burning sensation, and difficulty focusing during near work. Participants were then categorized into asthenopic and non-asthenopic groups according to their symptom status based on the questionnaire scoring.

After questionnaire completion, all participants underwent objective binocular vision assessment. Best-corrected visual acuity was measured using a Snellen chart to confirm eligibility. Refractive status was assessed before binocular testing to ensure that visual function was evaluated under corrected conditions. Near point of convergence was measured to assess convergence ability during near fixation. Ocular alignment and near phoria were evaluated using the cover test. Positive and negative fusional vergence were measured at near using prism bars to assess vergence reserves. Accommodative amplitude was assessed using the push-up method, and accommodative facility was evaluated at a 40 cm working distance using ±2.00 diopter lenses. Vergence facility was measured to determine the flexibility and speed of vergence responses during near visual tasks. The main clinical outcome variables were near point of convergence, positive fusional vergence break, negative fusional vergence break, accommodative amplitude, accommodative facility, and vergence facility.

Asthenopia status was considered the primary grouping variable, while binocular vision parameters were treated as the main outcome variables. Digital device-related variables, including daily screen time, device type, visual breaks, and symptom worsening after prolonged device use, were recorded as exposure-related variables. Age and gender were documented as demographic variables. To reduce

measurement variability, participants were assessed using the same clinical procedures, and the binocular vision parameters were recorded in standard clinical units, including centimeters for near point of convergence, prism diopters for fusional vergence, diopters for accommodative amplitude, and cycles per minute for accommodative and vergence facility.

Data were analyzed using SPSS version 26.0. Categorical variables, including gender, age group, device type, daily screen-time category, use of visual breaks, symptom worsening, asthenopia classification, and individual symptom frequencies, were summarized as frequencies and percentages. Continuous variables, including age and binocular vision parameters, were summarized using means and standard deviations. Binocular vision parameters were compared between asthenopic and non-asthenopic groups using the independent-samples t-test. A p-value of less than 0.05 was considered statistically significant. Data were checked for completeness before analysis, and participant confidentiality was maintained throughout data handling and reporting. The study followed ethical principles for human-subject research, including voluntary participation, informed consent, privacy protection, and use of anonymized data for analysis.

RESULTS

A total of 70 pre-presbyopic adults were included in the analysis. The mean age of participants was 30.59 ± 5.64 years, with the largest age subgroup being 26–30 years, comprising 21 participants (30.0%). The sample had a nearly balanced gender distribution, with 34 males (48.6%) and 36 females (51.4%). Tablet use was the most frequently reported primary digital device, reported by 19 participants (27.1%), followed by desktop computers in 18 participants (25.7%), laptops in 17 participants (24.3%), and smartphones in 16 participants (22.9%).

Daily screen exposure was highest in the >8-hour category, reported by 24 participants (34.3%), while 20 participants (28.6%) reported <3 hours of daily screen use. Visual break behavior was evenly distributed, with 35 participants (50.0%) reporting visual breaks and 35 participants (50.0%) reporting no visual breaks. Increased symptoms after prolonged digital device use were reported by 37 participants (52.9%), while 33 participants (47.1%) did not report symptom worsening after prolonged use.

Table 1. Demographic Characteristics and Digital Device-Use Patterns of Participants

Variable	Category	Frequency (n)	Percentage (%)
Age group	20–25 years	17	24.3
	26–30 years	21	30.0
	31–35 years	14	20.0
	36–40 years	18	25.7
Gender	Male	34	48.6
	Female	36	51.4
Primary digital device used	Smartphone	16	22.9
	Laptop	17	24.3
	Desktop	18	25.7
	Tablet	19	27.1
Daily screen time	<3 hours	20	28.6
	3–6 hours	12	17.1
	6–8 hours	14	20.0
	>8 hours	24	34.3
Visual breaks during device use	Yes	35	50.0
	No	35	50.0
Increased symptoms after prolonged device use	Yes	37	52.9
	No	33	47.1

Asthenopia was common in the study population. Based on CISS classification, 44 participants (62.9%) were categorized as asthenopic, while 26 participants (37.1%) were categorized as non-asthenopic. Eye strain and headache were the most frequently reported symptoms, each present in 39 participants (55.7%). Double vision was reported by 38 participants (54.3%), ocular fatigue by 37 participants (52.9%), burning sensation by 36 participants (51.4%), and blurred vision by 35 participants (50.0%). Difficulty focusing was the least frequently reported symptom but was still present in 31 participants (44.3%).

Table 2. Asthenopia Classification and Symptom Profile of Participants

Variable	Category	Frequency (n)	Percentage (%)
CISS classification	Asthenopic	44	62.9
	Non-asthenopic	26	37.1
Eye strain	Yes	39	55.7
	No	31	44.3
Headache	Yes	39	55.7
	No	31	44.3
Blurred vision	Yes	35	50.0
	No	35	50.0
Double vision	Yes	38	54.3
	No	32	45.7
Ocular fatigue	Yes	37	52.9
	No	33	47.1
Burning sensation	Yes	36	51.4
	No	34	48.6
Difficulty focusing	Yes	31	44.3
	No	39	55.7

Binocular vision parameters were compared between asthenopic and non-asthenopic participants. The mean near point of convergence was 8.23 ± 1.94 cm in the asthenopic group and 8.77 ± 2.06 cm in the non-asthenopic group, with a mean difference of −0.54 cm and no statistically significant group difference (95% CI: −1.54 to 0.46; p=0.280). Positive fusional vergence break was 22.45 ± 4.16 prism diopters in asthenopic participants and 21.96 ± 5.22 prism diopters in non-asthenopic participants, showing a small mean difference of 0.49 prism diopters that was not statistically significant (95% CI: −1.93 to 2.91; p=0.665). Negative fusional vergence break was also comparable between groups, with a mean of 17.89 ± 4.25 prism diopters in the asthenopic group and 18.42 ± 4.49 prism diopters in the non-asthenopic group (mean difference: −0.53; 95% CI: −2.72 to 1.66; p=0.619).

Accommodative amplitude was slightly higher among asthenopic participants, with a mean value of 11.41 ± 2.41 D compared with 10.73 ± 2.29 D in non-asthenopic participants; however, this difference was not statistically significant (mean difference: 0.68 D; 95% CI: −0.48 to 1.84; p=0.251). Accommodative facility was nearly identical between groups, measuring 10.75 ± 2.90 cycles per minute in asthenopic participants and 10.96 ± 2.92 cycles per minute in non-asthenopic participants (mean difference: −0.21 cpm; 95% CI: −1.66 to 1.24; p=0.770). Vergence facility was 10.80 ± 2.70 cycles per minute in asthenopic participants and 11.31 ± 2.78 cycles per minute in non-asthenopic participants, with no statistically significant difference between groups (mean difference: −0.51 cpm; 95% CI: −1.88 to 0.86; p=0.451). The effect sizes for all binocular vision comparisons were small, ranging from −0.27 to 0.29, indicating minimal between-group differences across measured clinical parameters.

Table 3. Comparison of Binocular Vision Parameters Between Asthenopic and Non-Asthenopic Participants

Binocular Vision Parameter	Asthenopic Group, n=44 Mean ± SD	Non-Asthenopic Group, n=26 Mean ± SD	Mean Difference	95% CI for Mean Difference	Cohen's d	p-value
Near point of convergence (cm)	8.23 ± 1.94	8.77 ± 2.06	−0.54	−1.54 to 0.46	−0.27	0.280
Positive fusional vergence break (PD)	22.45 ± 4.16	21.96 ± 5.22	0.49	−1.93 to 2.91	0.11	0.665
Negative fusional vergence break (PD)	17.89 ± 4.25	18.42 ± 4.49	−0.53	−2.72 to 1.66	−0.12	0.619
Accommodative amplitude (D)	11.41 ± 2.41	10.73 ± 2.29	0.68	−0.48 to 1.84	0.29	0.251
Accommodative facility (cpm)	10.75 ± 2.90	10.96 ± 2.92	−0.21	−1.66 to 1.24	−0.07	0.770
Vergence facility (cpm)	10.80 ± 2.70	11.31 ± 2.78	−0.51	−1.88 to 0.86	−0.19	0.451

Overall, the results showed a high frequency of asthenopic symptoms among pre-presbyopic digital device users, with nearly two-thirds of participants classified as asthenopic and more than half reporting eye strain, headache, double vision, ocular fatigue, burning sensation, or symptom worsening after prolonged device exposure. Despite this symptom burden, none of the measured binocular vision parameters showed a statistically significant difference between asthenopic and non-asthenopic participants. The small effect sizes and confidence intervals crossing zero across all comparisons indicate

that the clinical measurements of convergence, fusional vergence, accommodative amplitude, accommodative facility, and vergence facility were broadly comparable between the two groups.

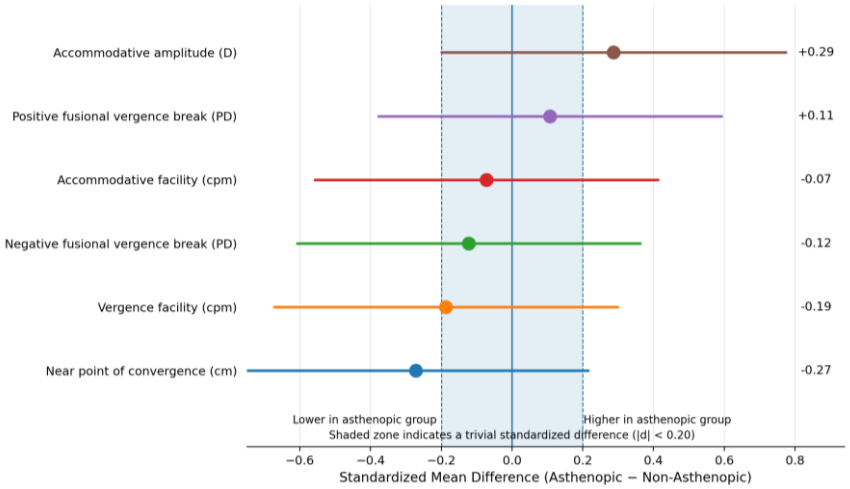

Figure 1. Standardized Differences in Binocular Vision Parameters by Asthenopia Status

The standardized comparison of binocular vision parameters showed uniformly small between-group effects, with Cohen's d values ranging from −0.27 to +0.29. Accommodative amplitude was slightly higher in the asthenopic group (d=+0.29), whereas near point of convergence showed the largest negative standardized difference (d=−0.27), indicating a marginally lower mean value among asthenopic participants. Positive fusional vergence demonstrated a negligible positive difference (d=+0.11), while negative fusional vergence (d=−0.12), accommodative facility (d=−0.07), and vergence facility (d=−0.19) remained within or close to the trivial-effect range. Overall, the figure supports the finding that symptom-defined asthenopia was not accompanied by clinically meaningful standardized differences in measured binocular vision parameters.

DISCUSSION

The present study evaluated binocular vision parameters and digital device-use patterns among asthenopic and non-asthenopic pre-presbyopic adults and found that asthenopic symptoms were highly prevalent, affecting 44 of 70 participants (62.9%). Eye strain and headache were the most frequently reported symptoms, each present in 39 participants (55.7%), followed by double vision in 38 participants (54.3%), ocular fatigue in 37 participants (52.9%), burning sensation in 36 participants (51.4%), blurred vision in 35 participants (50.0%), and difficulty focusing in 31 participants (44.3%). More than one-third of participants reported daily screen exposure exceeding 8 hours, and 52.9% experienced worsening symptoms after prolonged digital device use, indicating a substantial symptom burden in this pre-presbyopic population. Despite this high frequency of visual discomfort, none of the assessed binocular vision parameters differed significantly between asthenopic and non-asthenopic participants, suggesting that symptom presence was not strongly reflected in routine clinical measures of convergence, fusional vergence, accommodative amplitude, accommodative facility, or vergence facility.

The absence of statistically significant differences between groups is clinically important because asthenopia is often assumed to reflect underlying binocular or accommodative dysfunction. In the present analysis, near point of convergence was slightly lower in asthenopic participants than in non-asthenopic participants, while accommodative amplitude was slightly higher in the asthenopic group; however, these differences were small and statistically non-significant. Positive and negative fusional vergence break values, accommodative facility, and vergence facility were also broadly comparable between groups. These findings indicate that symptom-defined asthenopia may occur even when standard binocular vision parameters remain within a similar measurable range across symptomatic and asymptomatic individuals. This supports the concept that digital eye strain is not a single-mechanism

disorder but a multifactorial condition in which symptoms may arise from the combined effects of prolonged near demand, reduced blinking, ocular surface stress, lighting conditions, screen brightness, posture, viewing distance, and insufficient rest breaks rather than from binocular dysfunction alone (13,14).

These results are consistent with previous work showing that prolonged digital device use can produce visual discomfort without necessarily producing large or consistently measurable changes in standard binocular vision tests. Padavettan et al. reported that smartphone use may influence vergence and accommodative parameters, but the clinical magnitude of such changes may vary and may not always translate into clear group-level abnormalities (15). Similarly, reviews of digital eye strain have emphasized that symptoms such as eye strain, headache, ocular fatigue, and blurred vision are common among digital screen users, yet the relationship between subjective complaints and objective binocular or accommodative findings is often inconsistent (16,17). The present findings strengthen this interpretation by showing that even in a population with a high prevalence of asthenopic symptoms, the measured binocular parameters did not show significant separation between asthenopic and non-asthenopic groups.

The high symptom prevalence observed in this study may be partly explained by prolonged daily screen exposure and limited visual recovery during device use. A total of 24 participants (34.3%) reported more than 8 hours of daily screen time, and half of the sample did not report taking regular visual breaks. Prolonged exposure to near digital tasks increases sustained accommodative and convergence demand, particularly when screens are viewed at close working distances. In addition, digital screen use is associated with reduced blink frequency and incomplete blinking, which may destabilize the tear film and contribute to burning, dryness, ocular fatigue, and fluctuating blur (18). Therefore, the symptom profile observed in this study may reflect a combination of visual fatigue and ocular surface-related discomfort rather than isolated binocular vision dysfunction.

The finding that accommodative amplitude was slightly higher in asthenopic participants than in non-asthenopic participants is also noteworthy. If asthenopia were primarily caused by accommodative insufficiency, a lower accommodative amplitude would be expected in the symptomatic group. Instead, the small positive difference suggests that symptoms may not be explained by reduced focusing capacity alone. This pattern may reflect accommodative stress, sustained accommodative effort, or visual fatigue during prolonged near work rather than a measurable reduction in maximum amplitude. Similarly, the small differences in accommodative and vergence facility indicate that the speed and flexibility of accommodative and vergence responses were not substantially impaired in the asthenopic group. These findings reinforce the need to interpret asthenopic complaints in relation to both objective test results and real-world digital behavior.

The lack of significant binocular vision differences should not be interpreted as evidence that binocular assessment is unnecessary. Rather, it indicates that standard binocular vision measures alone may not fully explain symptom burden in digital device users. Clinical evaluation of asthenopia should therefore remain comprehensive, including refractive assessment, binocular vision testing, accommodative evaluation, ocular surface assessment, screen-use history, ergonomic review, and behavioral counseling. Patients with symptoms but normal binocular findings may still benefit from interventions targeting visual hygiene, including scheduled breaks, optimized viewing distance, appropriate screen brightness, reduced glare, conscious blinking, adequate room illumination, and improved posture. Conversely, individuals with measurable binocular dysfunction may require additional management such as optical correction, prism consideration, accommodative therapy, vergence therapy, or targeted follow-up depending on clinical findings (19).

The study also highlights the importance of using both symptom-based and objective clinical assessment tools. The Convergence Insufficiency Symptom Survey provides a structured method for quantifying near-vision symptoms, but symptoms captured by the questionnaire may arise from several mechanisms

beyond convergence insufficiency. Therefore, CISS-based classification can identify symptomatic individuals but should not be assumed to diagnose a specific binocular disorder without corresponding clinical signs. This distinction is especially relevant in digital eye strain research, where symptom questionnaires may capture ocular surface discomfort, visual fatigue, headache, attention difficulty, and ergonomic strain in addition to binocular vision symptoms. The present findings support the need for future studies to combine symptom scoring with objective binocular measures, ocular surface indicators, ergonomic variables, and screen-behavior metrics to better characterize the mechanisms of asthenopia.

Several methodological considerations should be acknowledged when interpreting these findings. The cross-sectional design allows comparison between asthenopic and non-asthenopic participants at one point in time but does not establish temporal or causal relationships between digital device exposure and symptom development. The convenience sampling approach may limit generalizability beyond similar clinical populations. The total sample size of 70 participants provided useful preliminary data, but smaller between-group differences may not have reached statistical significance. In addition, digital device exposure was assessed through participant-reported categories, which may be influenced by recall error. The study compared binocular vision parameters between symptom groups, but more advanced modeling would be needed to determine the independent contribution of screen time, device type, visual breaks, viewing distance, age, and gender to asthenopia status.

Overall, the findings suggest that asthenopia among pre-presbyopic digital device users is common but not necessarily accompanied by measurable impairment in standard binocular vision parameters. The small effect sizes across binocular measures indicate that symptomatic and asymptomatic participants had broadly similar clinical binocular profiles, while the high frequency of prolonged screen exposure and symptom worsening after device use points toward a multifactorial symptom pathway. These results support a practical clinical approach in which asthenopic patients are assessed not only for binocular and accommodative abnormalities but also for modifiable behavioral and environmental contributors to digital eye strain. Future research using larger samples, standardized CISS cut-off criteria, ocular surface testing, ergonomic assessment, and multivariable analysis may help distinguish which patients require binocular vision intervention and which are more likely to benefit from visual hygiene and digital-use modification.

CONCLUSION

This study found a high prevalence of asthenopia among pre-presbyopic adults using digital devices, with eye strain, headache, double vision, ocular fatigue, burning sensation, and blurred vision reported by a substantial proportion of participants. Although symptoms were common and more than half of the participants experienced worsening discomfort after prolonged device use, binocular vision parameters, including near point of convergence, positive and negative fusional vergence, accommodative amplitude, accommodative facility, and vergence facility, did not differ significantly between asthenopic and non-asthenopic groups. These findings suggest that asthenopic symptoms in pre-presbyopic digital device users may occur even when standard binocular vision measurements remain clinically comparable, highlighting the multifactorial nature of digital eye strain. Clinical assessment should therefore combine binocular vision evaluation with careful review of screen exposure, visual breaks, viewing habits, ergonomics, and ocular comfort, so that management can address both measurable visual dysfunction and modifiable behavioral or environmental contributors

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