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Research Article

EFFECT OF DIGITAL SCREEN ON VISUAL ACUITY AND NEAR POINT OF ACCOMMODATION

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Introduction: In recent years, the widespread use of digital devices such as smart phones, tablets, laptops, and desktop computers has significantly increased.[1] These devices have become an essential part of daily life for education, work, and entertainment. However, prolonged exposure to digital screens has raised concerns about their potential impact on eye health, particularly on visual acuity and the near point of accommodation.[2] Visual acuity refers to the clarity or sharpness of vision, which allows individuals to distinguish fine details of objects at a specific distance. It is an important indicator of the overall functioning of the visual system.[3] Continuous focus on digital screens for extended periods may lead to symptoms such as eye strain, blurred vision, headaches, and dryness, which can temporarily affect visual acuity.[4]

Materials and methods: A Descriptive Cross-sectional study was conducted in the Department of Physiology, Department of Ophthalmology, University Campus and Boys & Girls Hostel of Index Medical College Hospital, Indore from 01-01-2023 to 31-12-2024. The study is specifically confined to undergraduate medical students (MBBS). It often focuses on specific year levels (e.g., All 3rd to 5th year MBBS students) to ensure participants have had significant exposure to digital learning are included in the study. We took 310 samples. Out of 310 the control samples were 34. All the medical college students within the age group 17-25 years without any systemic complications like diabetes, hypertension, and tuberculosis were included in the study. Students who were taking medications like steroids or immune suppressants were excluded and those who do not give informed

written consent were also excluded from the study.

Results: A total of 310 undergraduate medical students participated in the study. The minimum age of the students was 17 years and the maximum age was 25 years and the Mean age was 20±1.45. Among the total sample population, 65.5% (203) were female 34.5% (107) were male. 53.9% of the students belong to urban areas, 30% to semi-urban areas, and the rest 16.1% to rural areas. 64.5% were hostellers and the rest 35.5% were day scholars. Prolonged screen time exposure is significantly associated with an increase in the Near Point of Accommodation (NPA), meaning the eyes' ability to focus on very close objects decreases, leading to eye strain and potentially myopia progression. Increased screen time is significantly associated with a higher risk of reduced visual acuity, primarily due to the development and progression of myopia (nearsightedness) and symptoms of digital eye strain (Computer Vision Syndrome or CVS).

Conclusion: The study on the effect of digital screen usage on visual acuity and near point of accommodation (NPA) shows that prolonged exposure to digital devices can negatively influence eye function. Continuous use of smart phones, computers, and tablets increases visual strain, which may lead to symptoms such as blurred vision, eye fatigue, headaches, and difficulty focusing on near objects. The findings indicate that excessive screen time can temporarily reduce visual acuity and increase the near point of accommodation, meaning the eyes need to hold objects farther away to focus clearly. This occurs because the eye muscles responsible for focusing become strained after long periods of near work on digital screens.

Key Words: Visual acuity, near point of accommodation, myopia, headaches, and dryness.

INTRODUCTION

In recent years, the widespread use of digital devices such as smart phones, tablets, laptops, and desktop computers has significantly increased.[1] These devices have become an essential part of daily life for education, work, and entertainment. However, prolonged exposure to digital screens has raised concerns about their potential impact on eye health, particularly on visual acuity and the near point of accommodation.[2]

Visual acuity refers to the clarity or sharpness of vision, which allows individuals to distinguish fine details of objects at a specific distance. It is an important indicator of the overall functioning of the visual system.[3] Continuous focus on digital screens for extended periods may lead to symptoms such as eye strain, blurred vision, headaches, and dryness, which can temporarily affect visual acuity.[4]

The near point of accommodation (NPA) is the closest distance at which the eye can focus clearly on an object. It depends on the ability of the eye’s lens to change its shape through the action of the ciliary muscles. Excessive screen usage requires sustained near work, which may cause fatigue of the

accommodative system and alter the near point of accommodation.[6]

The increasing dependence on digital devices has led to a rise in conditions such as digital eye strain and computer vision syndrome. These conditions are associated with prolonged screen exposure and may influence both visual acuity and accommodative functions of the eye.[7,8]

Therefore, understanding the effect of digital screen exposure on visual acuity and the near point of accommodation is important. Studying this relationship can help in identifying potential visual problems and in promoting healthy screen habits to protect eye health, especially among students and young adults who are frequent users of digital devices.

MATERIALS AND METHODS

Research Design: A Descriptive Cross-sectional study.

Research approach: This Descriptive cross-sectional study is an observational, non-experimental research design, it analyzes data from a population at single, specific point in time. It measures the prevalence of health outcomes, behaviors or characteristics in a population at a single specific point in time.

Schematic representation of research design:

Research Approach- Quantitative Approach

Research Design- Descriptive Cross-sectional Study

Objective: Study to estimate the impact and prevalence of Digital eye strain among undergraduate medical students

Assumptions: Prevalence and Symptoms

Study Setting: Department of Physiology, Department of Ophthalmology, University Campus and Boys & Girls Hostel of Index Medical College Hospital, Indore.

Target Population: All 3rd to 5th year MBBS students) to ensure participants have had significant exposure to digital learning

Sampling Technique: Non-Probability Method-Non-Random (Convenience Sampling-Selecting participants who are easy to reach.)

Sample: 310 Samples

Tool for Data Collection: questionnaires, interviews, observations tools. Tests-Snellen eye Chart and RAF ruler Test.

Data Analysis: Results are expressed in mean, Standard deviation & percentages. The Chi-square test was applied to test.

Setting of the study: The research was carried out from 01-01-2023 to 31-12-2024 at Department of Physiology and Department of Ophthalmology at Index Medical College Hospital and research center, Indore and some part of research was carried out at Malwanchal University campus as well as Boys & Girls Hostel campus of Index medical college and Hospital as participants convenience. Research is generally limited to students within Index medical college hospital and Malwanchal university campus to maintain a controlled sample environment.

Population (General): All the MBBS students of Index medical college hospital and research center within the age group of 17-25 years without any systemic complications like diabetes, hypertension, and tuberculosis were included in the study.

Target Population: The study is specifically confined to undergraduate medical students (MBBS). It often focuses on specific year levels (e.g., **All 3rd to 5th year MBBS students**) to ensure participants have had significant exposure to digital learning.

Sample: We took 310 samples, Out of 310 the control samples were 34.

Sample Size Calculation/Power analysis:

For a cross-sectional study among medical students, the sample size is usually determined using **Cochran's Formula** for prevalence:

A sample size of **310 medical students** is typically sufficient for this study, as it provides a **95% confidence level** with a **5.5% margin of error**, assuming a 55.8% prevalence of Digital Eye Strain (DES). The sample size was calculated by the following assumption: 95% confidence interval, a margin of error of 5%, and a prevalence of DES of 55.8% among medical college students from a previous study by Khan et al. The sample size was calculated to be 289. 10 % was added up and finally, we took 310 samples.

Students who were taking medications like steroids or immune suppressants were excluded and those who do not give informed written consent were also excluded from the study.

Sampling Technique: By using the Non-Probability Method-Non-Random (Convenience Sampling-Selecting participants who are easy to reach.) all the eligible students were included in the study. The Control sample has less than or equal to 2-hour exposure /day.

Inclusion Criteria: All the medical college students within the age group 17-25 years without any systemic complications like diabetes, hypertension, and tuberculosis were included in the study.

Exclusion Criteria: Students who were taking medications like steroids or immune suppressants were excluded and those who do not give informed written consent were also excluded from the study.

Tools /Investigations used for Data Collection:

Data collection tools instrument was designed to gather, measure, and analyze information, categorized primarily into questionnaires, interviews, observations tools.

A semi-structured questionnaire developed by Segui M et al, was used to assess the prevalence of DES. Sociodemographic data were collected from the participants.

The questionnaire had 2 parts.

Part A: It contains information about the frequency of digital screen usage, hours spent on a digital screen, usage in a dark place, illumination, and symptoms.

Part B: It contains information about the frequency and intensity of 16 common symptoms leading to DES like Burning, Itching, Feeling of a foreign body, Tearing, Excessive Blinking Eye redness, Eye Pain, Heavy Eyelids, Dryness, Blurred Vision, Double Vision, Difficulty focusing for near vision, Increased sensitivity to light, Colored halos around objects, Feeling that sight is worsening, Headache etc.

Tests: 1) The Snellen Optometric chart (working distance 20 feet (6.1 m), size: 23x35.5, approximate thickness 0.8 to 1.0 mm) (GimaS. p.A.ViaMarconi, 1-20060 Gessate) was used to assess the best corrected visual acuity, at our institution by an ophthalmologist having aminimum5-yearpost-graduate experience.

Tests: 2) Royal Air Force (RAF) rule (2023 Bernell Corporation. 4016 North Home Street, Mishawaka, IN, 46545 USA) (consisting of a 50 cm long rule with a slider holding a rotating four-sided cube) was used to measure NPA (near point of accommodation). The NPA was measured using the RAF Rule and standard targets such as the Times Roman Type face, Reduced Snellen chart, etc. The measurement was carried out with full refractive correction in normal room illumination, where the examiner placed the cheek rest on the inferior orbital margin while holding the ruler. After this, the patients were requested to focus on the target, and the examiner gradually pushed the drum towards the patients' eyes at a 9, stable rate of about 1-2 cm per second (**Pushed up/Pushed away method**)

Ethical Consideration:

Clearance from the institutional Ethical committee (IEC) was obtained before the start of the study & informed written consent was obtained from the study participants.

Data Collection Procedure:

Data collection methods in research methodology are techniques used to gather information, categorized into primary (first-hand) and secondary (existing) sources. Key methods include surveys for broad, numerical data; interviews for in-depth insights; focus groups for group perspectives; and observations for behaviour. Selecting the right method depends on research aims and resource availability.

Plan of Data Analysis and Statistical Methods

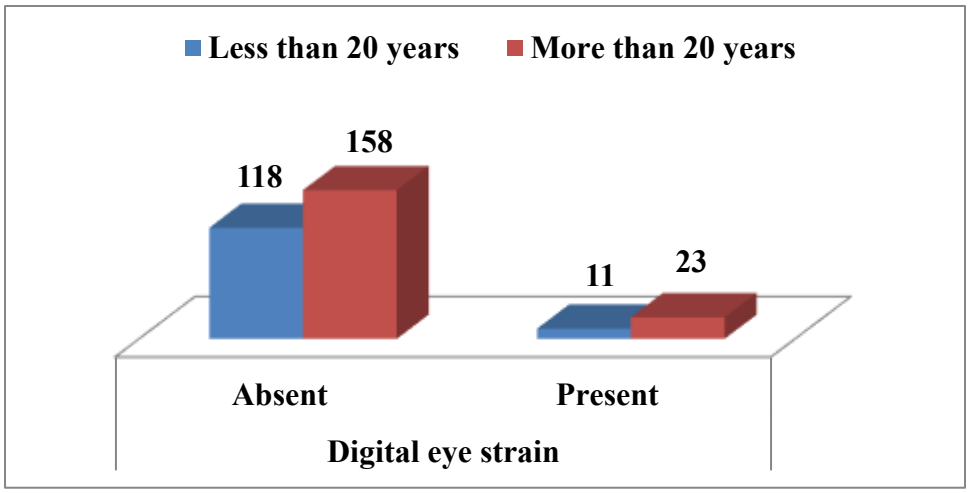
Data was entered in MS excel and analysis was done using PSPP version 1.6.2 software. Results are expressed in mean, Standard deviation & percentages. The Chi-square test was applied to test the association. For statistical purposes, p-value <0.05 were considered to be statistically significant.

RESULTS

A total of 310 undergraduate medical students participated in the study. The minimum age of the students was 18 years and the maximum age was 25 years and the Mean age was 20±1.45. Among the total sample population, 65.5% (203) were female 34.5% (107) were male. 53.9% of the students belong to urban areas, 30% to semi-urban areas, and the rest 16.1% to rural areas. 64.5% were hostellers and the rest 35.5% were day scholars.

Age group	Digital eye strain		P value
	Absent	Present	
Less than 20 years	118	11	1.34
More than 20 years	158	23	

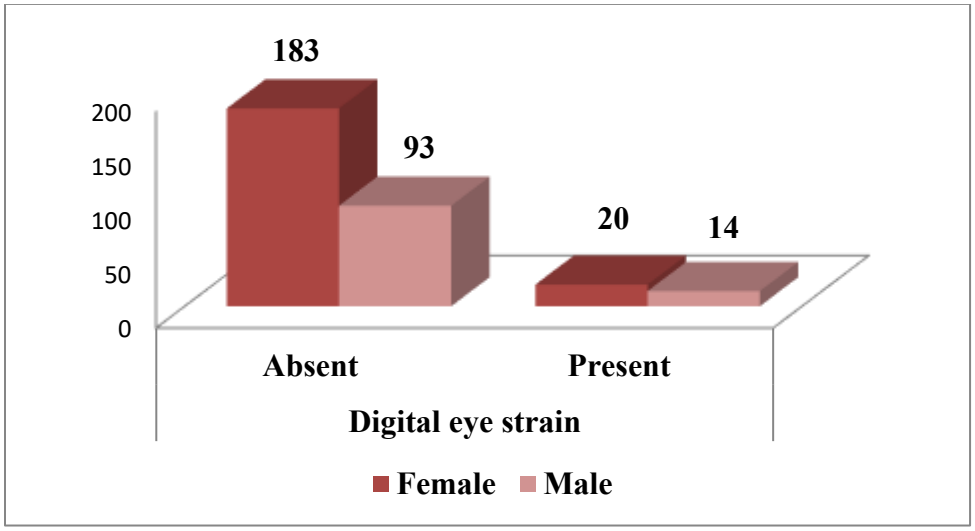
Table 1: Age distribution



Graph 1: Age distribution

Gender	Digital eye strain		P value
	Absent	Present	
Female	183	20	0.749
Male	93	14	

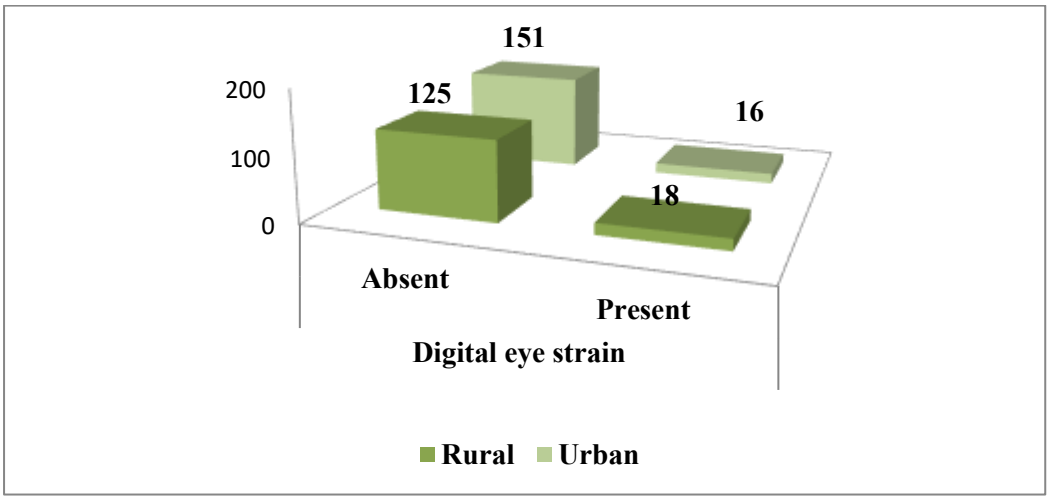
Table 2: Gender distribution



Graph 2: Gender distribution

Area	Digital eye strain		P value
	Absent	Present	
Rural	125	18	0.749
Urban	151	16	

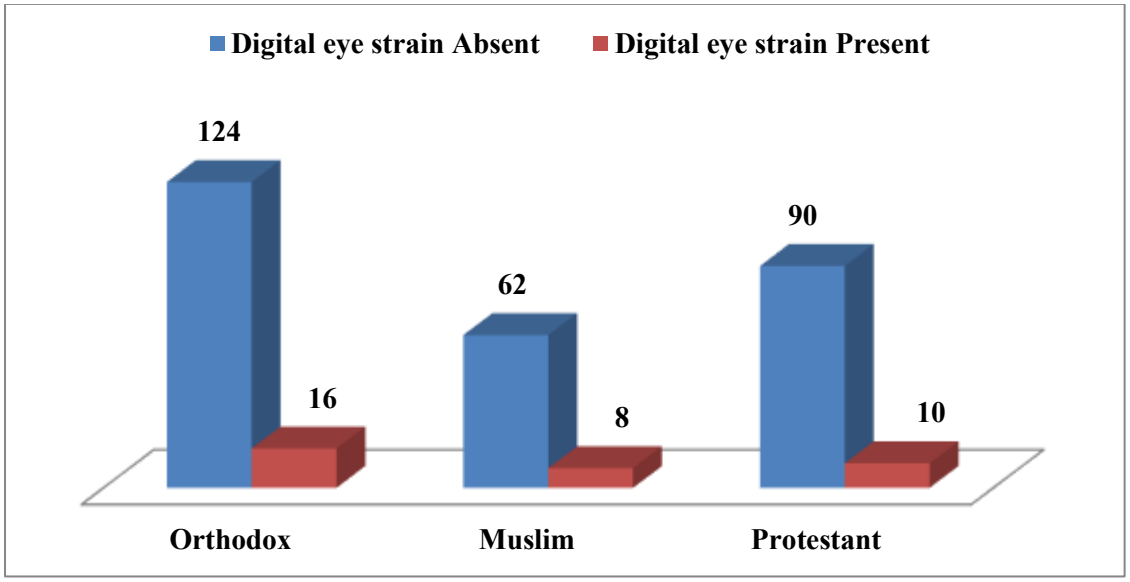
Table 3: Residence



Graph 3: Residence

Religious	Digital eye strain		P value
	Absent	Present	
Orthodox	124	16	0.751
Muslim	62	8	
Protestant	90	10	

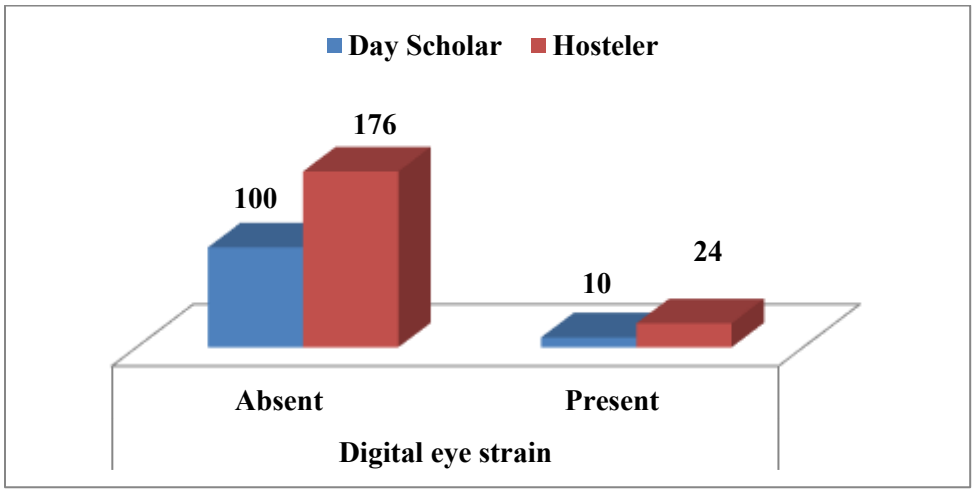
Table 4: Religious



Graph 4: Religious

Present Stay	Digital eye strain		P value
	Absent	Present	
Day Scholar	100	10	0.751
Hosteler	176	24	

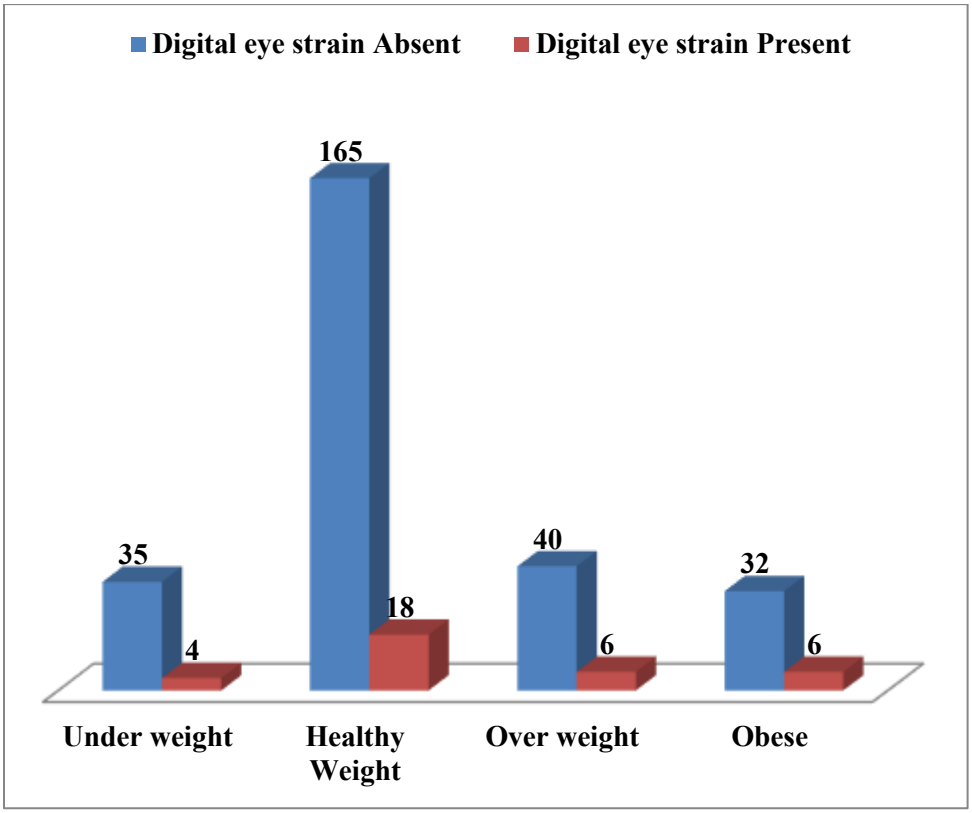
Table 5: Present Stay



Graph 5: Present Stay

BMI (Kg/m2)	Digital eye strain		P value
	Absent	Present	
Under weight	35	4	0.751
Healthy Weight	165	18	
Over weight	40	6	
Obese	32	6	

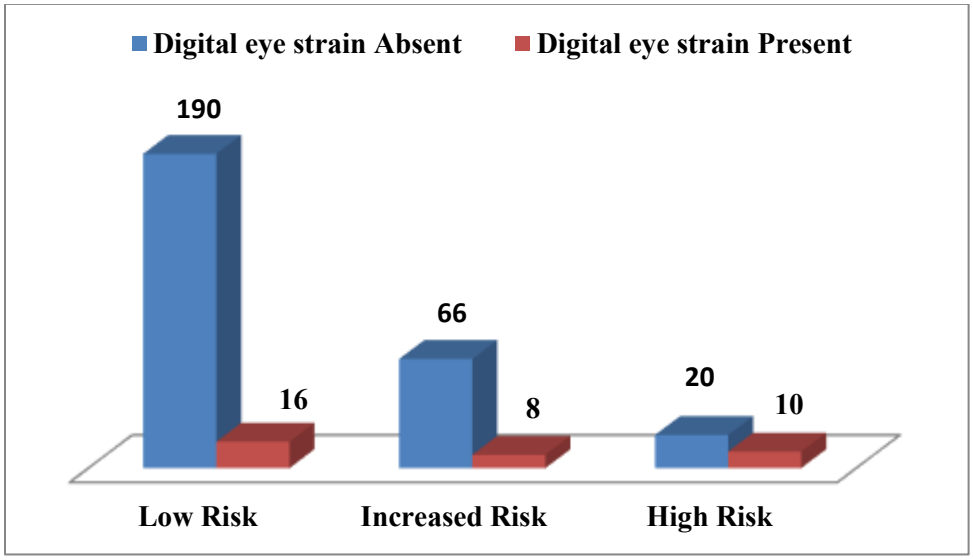
Table 6: BMI (Kg/m2)



Graph 6: BMI (Kg/m2)

Waist Circumference	Digital eye strain		P value
	Absent	Present	
Low Risk	190	16	0.751
Increased Risk	66	8	
High Risk	20	10	

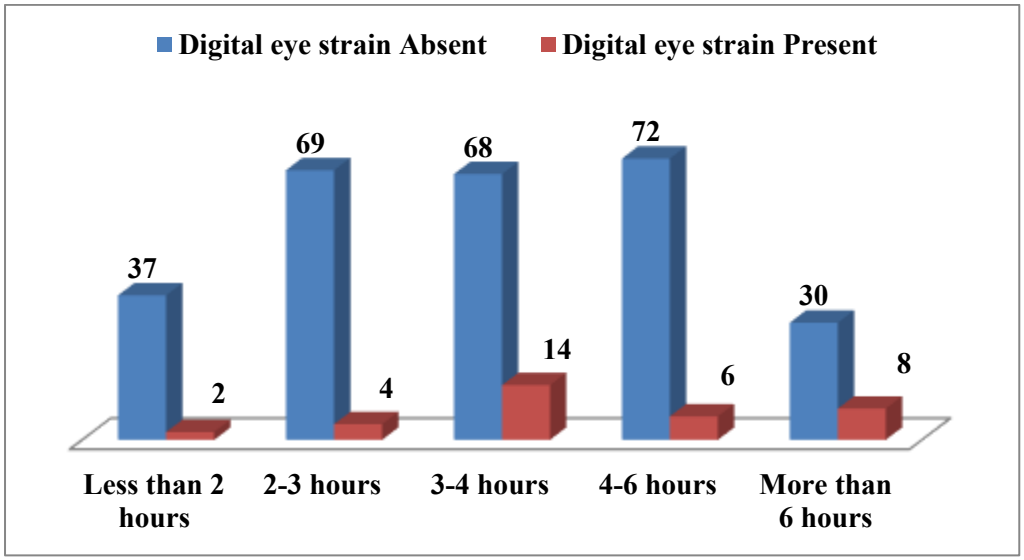
Table 7: Waist Circumference



Graph 7: Waist Circumference

Duration of screen usage	Digital eye strain		P value
	Absent	Present	
Less than 2 hours	37	2	11.55
2-3 hours	69	4	
3-4 hours	68	14	
4-6 hours	72	6	
More than 6 hours	30	8	

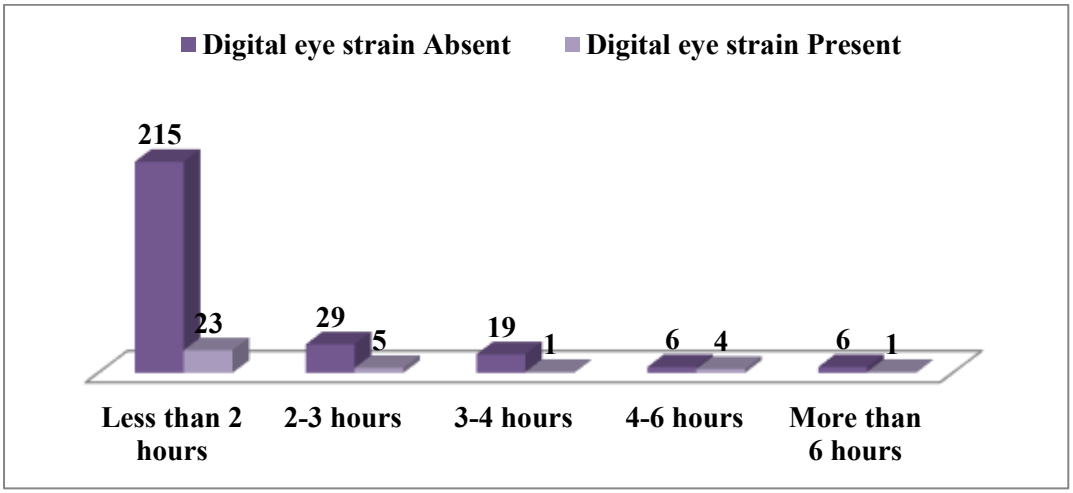
Table 8: Duration of screen usage



Graph 8: Duration of screen usage

Usage of a digital screen in dark hours	Digital eye strain		P value
	Absent	Present	
Less than 2 hours	215	23	11.55
2-3 hours	29	5	
3-4 hours	19	1	
4-6 hours	6	4	
More than 6 hours	6	1	

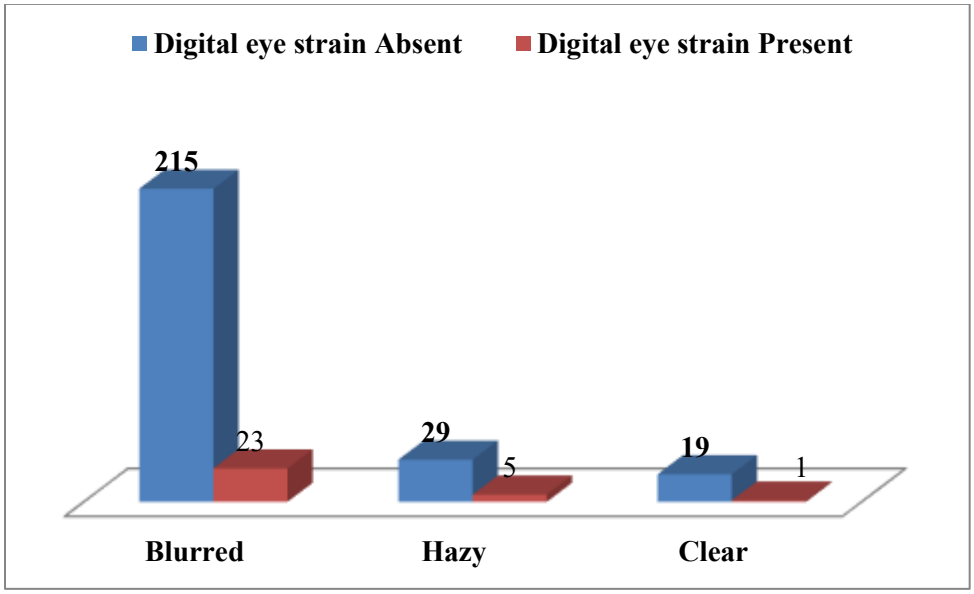
Table 9: Usage of a digital screen in dark hours



Graph 9: Usage of a digital screen in dark hours

Vision after long hours of usage of digital screen	Digital eye strain		P value
	Absent	Present	
Blurred	215	23	0.001
Hazy	29	5	
Clear	19	1	

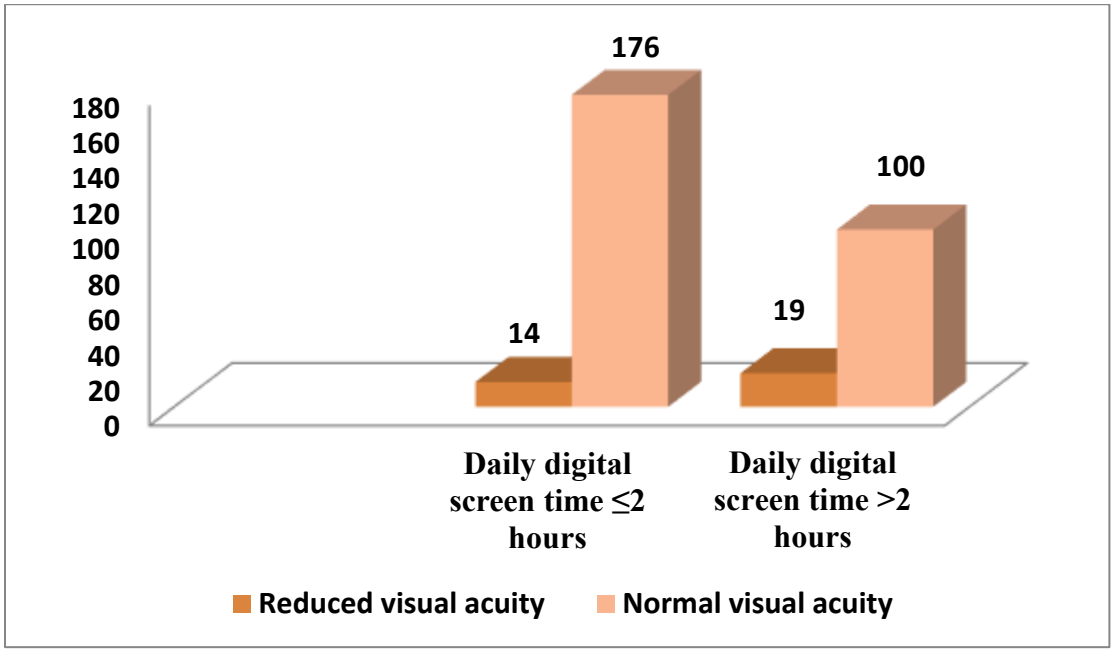
Table 10: Relationship between DES and vision after prolonged hours on digital screen



Graph 10: Relationship between DES and vision after prolonged hours on digital screen

Variables	Reduced visual acuity	Normal visual acuity
Daily digital screen time ≤2 hours	14 (41.17%)	176 (63.76%)
Daily digital screen time >2 hours	19 (55.88%)	100 (36.23%)

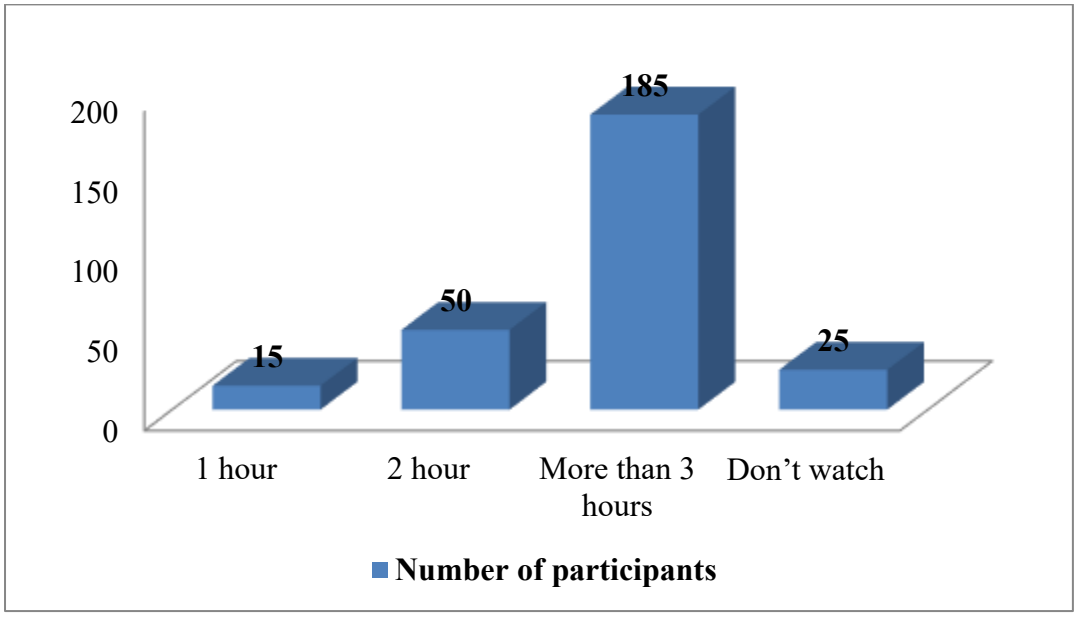
Table 11: Impact of screen time on visual acuity



Graph 11: Impact of screen time on visual acuity

Screen time in hours	Number of participants	Sleep duration	P value
1 hour	15	Between 6 and 7 hours	0.001
2 hours	50	Less than 6 hours	0.001
More than 3 hours	185	Less than 5 hours	0.001
Don't watch	25	More than 8 hours	0.001

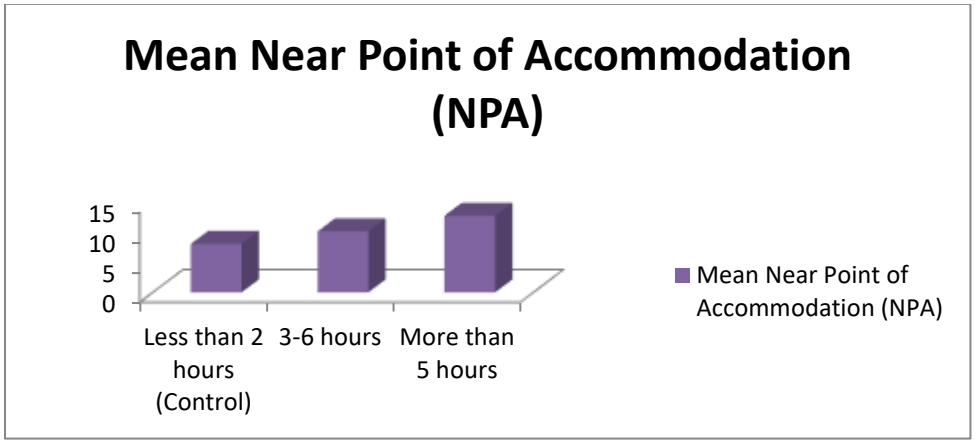
Table 12: Impact of screen time on sleep patterns



Graph 12: Impact of screen time on sleep patterns

S.No	Usage of a digital screen in dark hours	Mean Near Point of Accommodation (NPA)
1	Less than 2 hours (Control)	**8.1±1.4 cm**
2	3-6 hours	**10.2±2.1 cm**
3	More than 5 hours	**12.8±2.7 cm**

Table 13: Screen Time Exposure and Near point of Accommodation (NPA)



Graph 13: Screen Time Exposure and Near point of Accommodation (NPA)

Prolonged screen time exposure is significantly associated with an increase in the Near Point of Accommodation (NPA), meaning the eyes' ability to focus on very close objects decreases, leading to eye strain and potentially myopia progression.

The Near Point of Accommodation (NPA) is the closest point at which the eye can focus clearly. A normal, healthy young adult might have an NPA of around 6-8 cm (or an amplitude of accommodation of 14-16 Diopters). Research consistently shows that using screens for extended periods causes the NPA to move further away (increase in distance), indicating a reduction in accommodative ability or increased "lag of accommodation". This is often a sign of visual fatigue or accommodative dysfunction.

Increased screen time is significantly associated with a higher risk of reduced visual acuity, primarily due to the development and progression of myopia (nearsightedness) and symptoms of digital eye strain (Computer Vision Syndrome or CVS).

S.No	Usage of a digital screen in dark hours	Associated Visual Acuity Outcome	Key Associated Symptoms/Findings
1	Less than 2 hours (Control)	Normal visual acuity	**Lower incidence of digital eye strain symptoms**
2	3-6 hours	Worsening visual acuity	**Moderate incidence of digital eye strain, fatigue and dry eyes**
3	More than 5 hours	Poorer visual acuity	**High prevalence of severe digital eye strain symptoms, including persistent blurring of vision**

			and accommodative issues

Table 13: relationship between Screen Time Exposure and Visual acuity

While the exact number of symptoms can vary depending on research categorization, common issues associated with excessive screen time in young children include:

1. **Developmental Delays:** Particularly in communication/speech and problem-solving skills.
2. **Hyperactive Behaviors:** Such as being excitable, impulsive, restless, and having low attention spans.
3. **Attention Difficulties/Inattention:** Difficulty concentrating and high distractibility.
4. **Aggressive Behavior:** A higher likelihood of being aggressive and antisocial.
5. **Social Difficulties:** Poorer social skills and reduced pro-social behavior due to less face-to-face interaction.
6. **Emotional Problems:** Including symptoms of anxiety and depression.
7. **Sleep Disorders:** Shorter sleep duration, difficulty falling asleep, and restless sleep.
8. **Obesity/Overweight Risk:** Strong association with higher BMI and less physical activity.
9. **Poor Physical Activity:** Reduced time spent playing outdoors and lower physical activity levels.
10. **Unhealthy Dietary Habits:** Association with unhealthy eating behaviors, possibly due to exposure to food advertising.
11. **Eye Strain:** Symptoms like dry/itchy eyes, blurred vision, and headaches.
12. **Musculoskeletal Problems:** Neck, shoulder, and back pain from poor posture.
13. **Lower Academic Performance:** Worse math and vocabulary skills later in life.
14. **Bullying Behavior:** Increased risk of being a bully or a victim of bullying in school.
15. **Poorer Executive Function:** Impaired cognitive function related to planning and self-control.
16. **Atypical Sensory Behaviors:** Increased odds of exhibiting "high" sensation seeking or avoiding behaviors.

S.No	DES Symptoms	Visual Acuity Normal	Visual Acuity Reduced
1	Blur vision	0 (0)	4 (1.29%)
2	Burning	0 (0)	14 (4.516%)
3	Cervical Pain	0 (0)	9 (2.90%)
4	Colored halos around object	0 (0)	2 (0.64%)
5	Double Vision	0 (0)	4 (1.29%)
6	Dryness	5 (1.612%)	44 (15.80%)
7	Eye pain	2(0.64)	8 (2.58%)
8	Eye redness	0 (0)	5 (1.61%)
9	Feeling a foreign Body	0 (0)	8 (2.58%)
10	Heavy Eyelids	0 (0)	1 (0.322)

11	Headache	2(0.64)	110 (36.12%)
12	Itching	3 (0)	7(2.25)
12	Neck pain	2 (0.64)	1 (0.322)
13	Shoulder pain	1 (0.322)	0 (0)
14	Tearing	0 (0)	42 (13.54%)
15	No Symptoms	34 (16.19%)	0 (0)

Table 14: DES symptoms with visual acuity

This study confirms a relationship between excessive screen time and the appearance of numerous health symptoms across various domains, including physical, mental, and developmental health. Increasing screen time like 1-year, 2-year, or 3-year intervals for all individuals can increase severity of symptoms. The onset and severity of symptoms depend heavily on individual factors, the *amount* of screen time (e.g., >2 hours/day or >4 hours/day is often a critical threshold), the *type* of content, age of exposure, and lifestyle.

DISCUSSION

There are both pharmaceutical and non-pharmacological options for managing digital eye strain. To reduce symptoms of digital eye strain, simple actions such as good ergonomics, proper lighting, adjusting image parameters (resolution, text size, contrast, and luminance), correcting refractive error and presbyopia, correcting vergence and accommodative problems, and taking frequent breaks can significantly help.[11] Pharmacological treatment options include topical artificial tears. There are both pharmaceutical and non-pharmacological options for managing digital eye strain. Practicing good ergonomics, thinking and blinking, using appropriate lighting, adjusting image parameters (resolution, text size, contrast, luminance), correcting refractive error and accommodative problems, and taking frequent breaks can significantly reduce symptoms of digital eye strain. [12]

Prolonged screen use, which involves continuous near work, puts excessive strain on the eye's focusing muscles (ciliary muscles). This leads to several effects on accommodation and visual acuity[13]:

- **Altered Near Point of Accommodation (NPA):** Studies show that increased daily screen time significantly increases the mean NPA (meaning the closest distance at which the eye can focus moves further away), indicating reduced accommodative ability or accommodative fatigue.
- **Accommodative Spasm/Excess:** Sustained focus on a fixed near distance can cause the focusing system to temporarily "lock up" or spasm. This condition, known as accommodative spasm or excess, results in temporary blurred vision when looking away from the screen towards distant objects.
- **Reduced Visual Acuity:** There is a significant association between increased screen time and a reduction in normal visual acuity, particularly among heavy users. This can manifest as intermittent blurring of vision for both near and far objects.

- **Myopia Development/Progression:** In children and teenagers, excessive screen time is a major risk factor linked to the onset and progression of myopia (nearsightedness). Prolonged near work may cause the eyeball to elongate, leading to permanent changes in vision.

  To mitigate these effects, eye care professionals recommend practicing good visual hygiene[14,15]:

  The 20-20-20 rule: Every 20 minutes, take a 20-second break to look at an object at least 20 feet (6 meters) away.

  Maintain proper screen distance: Position screens at an arm's length (about 25 inches) and slightly below eye level.

  Ensure adequate environmental lighting and reduce screen brightness and glare.

  Blink deliberately and completely to help maintain tear film stability.

  Increase outdoor time, especially for children, as exposure to natural daylight is beneficial for vision development.

CONCLUSION

The study on the effect of digital screen usage on visual acuity and near point of accommodation (NPA) shows that prolonged exposure to digital devices can negatively influence eye function. Continuous use of smart phones, computers, and tablets increases visual strain, which may lead to symptoms such as blurred vision, eye fatigue, headaches, and difficulty focusing on near objects.

The findings indicate that excessive screen time can temporarily reduce visual acuity and increase the near point of accommodation, meaning the eyes need to hold objects farther away to focus clearly. This occurs because the eye muscles responsible for focusing become strained after long periods of near work on digital screens.

Therefore, it is important to adopt healthy digital habits such as taking regular breaks, maintaining proper screen distance, ensuring good lighting, and following practices like the 20-20-20 rule (looking at something 20 feet away for 20 seconds every 20 minutes). These measures can help reduce digital eye strain and protect visual health while using digital devices.

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