ORIGINAL RESEARCH ARTICLE

Digital Strain and its Impact on Visual and Auditory Health in an Online Learning Environment: A Cross-sectional Study

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ABSTRACT

Background: During the COVID-19 pandemic, concerns extended beyond respiratory health to include visual and auditory well-being in school-aged children. This study aimed to assess the prevalence and risk factors of digital device-related visual and auditory strain in children.

Methods: A cross-sectional descriptive study using simple random sample technique as well as multistage cluster sampling was carried out at selected schools at Puducherry, India, from January 2022 to May 2022. Using a self-administered questionnaire, demographic information as well as digital-related visual and auditory strain were evaluated.

Results: Of the 268 participants, 5.6% reported having moderate digital eye strain and 27.6% had mild digital eye strain. Students reported burning sensations (35.07%), dryness (20.14%), and itching (37.68%) as common visual discomforts. In the meantime, 7.5% of respondents reported significant auditory strain, and 10.4% reported mild strain. Ear irritation (17.91%), ear infections (7.46%), ringing in the ears (16.79%), and ear blockage (13.43%) are among the symptoms. Risk factors for eye strain included participant age (P=0.020), wearing spectacles (P<0.001), the number of hours spent using a device outside of class (P=0.009), and the distance between the device and the user (P=0.018). Age (P<0.05), sex (P<0.001), students' grade (P<0.001), hours spent (P<0.05), and headphone use (P<0.001) were all significantly correlated with auditory strain.

Conclusions: The hybrid learning environment posed diverse challenges for students, highlighting the significant impact of both visual and auditory health. The findings advocate for proactive measures for students' overall health.

Keywords: Auditory health, COVID-19 pandemic, Digital strain, Online learning, Schoolchildren, Visual health

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Introduction

The global pandemic profoundly altered pedagogical approaches worldwide, compelling a shift from traditional classroom settings to online teaching and learning practices.[1] The extensive use of digital devices in education surged during the pandemic, providing a means to safeguard individuals during lockdowns enforced to curb the spread of COVID-19. While this transition enabled the continuity of education amidst the lockdown, it introduced a fresh set of concerns associated with online learning and the heightened reliance on electronic devices, particularly among children. This pivot towards digital education became a lifeline for learning during the pandemic accompanied by its unique set of challenges.

The surge in online classes during the pandemic has led to a notable rise in children's screen time, with an increased reliance on digital devices such as computers, laptops, smartphones, and iPads.[2] In addition to this, the widespread use of audio devices like headphones, and earphones, has become a common practice among children for various activities such as attending online classes, engaging in social media, listening to music, and watching videos.[3] This extended exposure to digital screens and audio raised significant concerns regarding children's overall health, encompassing physical, mental, and social well-being. Initially, challenges related to hearing and vision emerged among many children, highlighting the potential impact of this extended digital engagement on their sensory health. It is essential to address and mitigate the potential health-related issues arising from this unprecedented increase in screen and audio usage among the younger generation.

Furthermore, the prolonged use of digital devices and headsets during online classes has raised concerns about potential visual and hearing problems in children.[4] A lack of awareness regarding screen time, viewing distance, and safe volume settings may increase the risk of various issues among students including blurred vision, headaches, itching, irritation, and hearing damage.[5,6] Researchers also voiced concerns that online learning might be contributing to an "alarming rate" of myopia, or nearsightedness, among children.[7]

This comprehensive study aims to elucidate the multifaceted impact of online learning and gadget usage on the visual and auditory health of school children during the COVID-19 pandemic. Additionally, the study aims to identify associated risk factors, and symptoms of digital-related visual and auditory strain specific to Puducherry, India.

Methodology

A cross-sectional descriptive study was conducted from January 2022 to May 2022 to assess students enrolled in high school and higher secondary education in Puducherry, India. The study focused on understanding the prevalence of visual & auditory strain among students aged between 13-18 years actively participating in online classes during the data collection period. The research was conducted in selected schools situated within the Puducherry region. Schools were selected using a multistage cluster sampling method to ensure representation of different geographical zones, including urban, semi-urban and rural areas. In the first stage, zones were randomized and in the second stage, schools within the selected zones were randomly chosen. Subsequently, a simple random sampling technique was used to choose 268 participants from the selected schools. The sample size was calculated based on a 0.701 prevalence rate of visual strain, with 6% absolute precision, 5% alpha error, and a non-responsive rate of 20%.[8] During the third wave of the COVID-19 lockdown in India, high school and higher secondary students followed a hybrid learning model. This approach involved a combination of active participation in online classes from home and attending in-person instruction at school on alternating days. The participants' data was collected while they were on the school grounds. Before being included in the study, every participant gave their written and verbal informed consent, ensuring a comprehensive and ethical approach to data collection. The study was approved by the institutional research committee and ethics committee of Vinayaka Mission's College of Nursing, Puducherry, India (IRC No: VMCON-IRC-2021-2022-091; IEC No: VMCN PDY/IEC 2022/080).

The questionnaire included sections on the demographic information of the participants, 20 questions assessing digital-related ocular strain, and 8 questions evaluating digital-related auditory strain. Each question was answered with a "Yes" or "No," where a "Yes" response was scored as 1 and a "No" as 0. The total scores for ocular strain ranged from 0 to 20, categorized as 0-6 as Normal, 7-13 as Mildly affected and 14-20 as Moderately affected. Similarly, auditory strain scores ranged from 0 to 8, with 0-2 indicating Normal, 3-5 indicating Mildly affected, and 6-8 indicating Moderately affected.

Statistical analysis: The collected data was analyzed using SPSS v21, incorporating both descriptive and inferential statistics. Descriptive statistics, such as frequency and percentage, were used to characterize demographic variables, while the chi-square test was used to identify the associations between different categorical variables and demographical variables. A *p*-value less than 0.05 was considered statistically significant.

Results

According to Table 1, the study participants' average age was 14.79±1.12. The majority of students belong to the age of 14 years (29.9%). Among the 268 students, 81.7% were female and 19.3% were male. This study involved students from various grades, with the highest representation from the 10th standard (32.5%). Notably, 53.3% of students attended online

Table 1: Demographic profile of the participants

Variables	Participants(%)
Age(yrs)	
13	37 (13.8)
14	80 (29.9)
15	68 (25.4)
16	72 (26.8)
17	11 (4.1)
Gender	
Male	49 (18.3)
Female	219 (81.7)
Class Standard	
9th	61 (22.8)
10th	87 (32.5)
11th	47 (17.5)
12th	73 (27.2)
Attending Online Classes	
Yes	142 (53)
No	56 (20.9)
Sometime	70 (26.1)
No. of Hours online classes	
1 hour	116 (43.3)
2 hours	64 (23.9)
3 hours	21 (7.8)
4 hours	22 (8.2)
5 hours	45 (16.8)
Types of devices used for online classes	
Smart Phone	247 (92.2)
Desktop	16 (6)
Laptop	4 (1.5)
i-pad/tablet	1 (0.4)
Wearing protective eye glass	23 (8.6)
Wearing Spectacles	52 (19.4)
Distance of mobile phone	
Nearby	59 (22)
Faraway	17 (6.3)
Normal	192 (71.6)
Position	
Sitting	138 (51.5)
Lying	20 (7.5)
Both	110 (41.3)
Level of screen brightness	
10%	68 (25.4)
30%	104 (38.8)
50%	74 (27.6)
80%	20 (7.5)
100%	2 (0.7)
Using devices other than online classes	208 (77.6)
Using Hearing devices	161 (60.1)
Types of devices	
Headphone	88 (32.8)
Ear pods	50 (18.6)
Speakers	23 (8.5)
None of the above	107 (39.9)
Headphone	
<2 hours	176 (65.7)
2-4 hours	58 (21.6)
4-6 hours	11 (4.1)
>6 hours	23 (8.6)
Hearing	
Continuously	39 (14.6)
Intermittent	98 (36.6)
Occasionally	131 (48.9)
Increases Volume	
Yes	120 (44.8)
No	106 (39.6)
Occasionally	42 (15.7)
How many hours gadget is used other than online classes	
1 hour	100 (37.3)
2 hours	58 (21.6)
3 hours	57 (21.3)
4 hours	20 (7.5)
5 hours	22 (8.2)
6 hours	11 (4.1)

classes during the pandemic and around 43.3% of the participants spent a minimum of 1 hour in online classes. Remarkably, a smartphone was the most preferred device (92.2%). 19.40% of participants used to wear spectacles, whereas 80.6% of students generally do not wear spectacles. In addition, 8.6% of study participants used protective eyeglasses while engaging with digital devices.

The present study shows that most of the students (71.6%) keep their smartphones at a normal distance during classes. 51.5% of the students preferred the sitting position over the supine position during online classes. Additionally, 38.8% of the students generally used 30% of screen brightness in their smartphones. Many students used digital devices for entertainment, playing games (77.6%) other than online classes. 37.3% of the students used digital devices for more than one hour per day. Table 1 also shows that most of the students (60.1%) used hearing devices for attending online classes. About 32.8% of students used headphones, 18.6% used ear pods, and 8.5% used speakers. Most students (87.3%) used headphones for less than 4 hours a day. Most of these students (50.1%) used headphones continuously and intermittently for attending classes. About 44.8% adjusted the volume of the headphones to suit their needs while attending online classes.

The results of the current study revealed that 5.6% of participants experienced moderate effects of digital eye strain, while 27.6% of students were mildly affected by digital eye strain. As seen in Table 2, a significant percentage of students experienced different types of ocular discomfort. Notably, 37.68% reported experiencing itching, 22.38% had redness, and 35.07% felt a burning sensation in their eyes. Additionally, 19.4% perceived double vision on digital screens, while 25.37% sensed a foreign body in their eyes. Approximately 20.14% reported dryness, 32.83% felt sensitivity to bright light, and 25% encountered blurred vision. 36.19% of students mentioned tearing of eyes during online sessions, and 35.82% of students expressed eye fatigue. Most of the students reported frequent blinking, while 34.32% admitted light intolerance at night. Additionally, 33.58% experienced eye pain and 17.91% struggled with nearsightedness. About 30.22% admitted that their eyes are strained more during classes, and almost half of the respondents suffered from headaches. Furthermore, 25.74% encountered screen glare, 16.79% reported eye swelling, and 16.41% felt heaviness in their eyes. This comprehensive survey highlights the diverse ocular challenges students face during virtual learning.

In reference to ear strain associated by attending online courses, 10.4% of participants reported mild symptoms, 7.5% reported moderate symptoms. Table 3, displays a notable percentage of students experienced auditory stress during classes online. Specifically, 27.23% of participants reported experiencing migraines while wearing hearing aids during virtual classes, while 26.86% faced difficulties in hearing

Table 2: Frequency & Percentage distribution of Digital Related Ocular Strain

Digital Ocular Strain	Participants (%)
Itching in eyes	167 (62.31)
Redness in eyes	208 (77.61)
Burning sensation in eyes	174 (64.92)
Double vision	216 (80.59)
Feeling of a foreign body in the eye	200 (74.62)
Dryness of eyes	114 (42.53)
Sensitivity to bright light	180 (67.16)
Blurred vision	201 (75)
Tearing from the eyes	171 (63.8)
Eyes are tired	164 (61.17)
Blinking eyes often	201 (75)
Intolerant to light during night	176 (65.67)
Pain in eyes	178 (66.41)
Difficulty in seeing the objects near	220 (82.08)
Difficulty in seeing the objects in the distance	186 (69.4)
Straining of eyes	187 (69.77)
Headache	131 (48.88)
Lightning or glare	199 (74.25)
Swelling of eyes	223 (83.2)
Heaviness in eyes	224 (83.58)

Table 3: Frequency & Percentage distribution of Digital Related Auditory Strain

Digital Auditory Strain	Participants (%)
Difficulty in hearing while attending class	72 (26.86)
Headache while using earphones	73 (27.23)
Pain in the ears while using earphones	54 (20.14)
Hearing loss	22 (8.2)
Irritation	48 (17.91)
Infection	20 (7.46)
Feeling of ringing in ears	45 (16.79)
Ear blocking	36 (13.43)

clearly. Furthermore, 20.14% of students reported earache while attending online classes. 8.2% of the students reported hearing loss when utilizing audio devices during virtual classes. In the realm of discomfort, 17.91% of students reported irritation in their ears, with 7.46% even reported ear infections due to prolonged use of hearing devices. Furthermore, 16.79% of participants reported a ringing sensation in their ears, and 13.43% experienced ear blockage during virtual sessions. This result underscores the multifaceted challenges students faced, not only in visual but also in auditory aspects, throughout their online learning experiences.

Based on the univariate analysis, various parameters are shown in Table 4 that are related to the level of digital eye strain. Interestingly, there was a significant correlation (P=0.020) between the respondents' age. Additionally, there was a significant correlation (P<0.001) between wearing spectacles and digital eye strain. The time spent on digital devices for online classes and the distance at which smartphones were used during classes showed a correlation with eye strain (P=0.009 and P=0.018, respectively). These results underscore the wide range of variables that influence eye strain among students.

Table 5 demonstrates the univariate analysis indicated a significant association between the occurrence of ear strain among students and other parameters. Notably, it was shown that the following risk factors were statistically significant and robust: age (P<0.05), gender (P<0.001), students' grades (P<0.001), hours spent using hearing devices (P<0.05), and, frequency of hearing (P<0.001). These results highlight the complex nature of the problem and underscore the importance of considering these factors when addressing and mitigating ear strain concerns in student populations.

Discussion

The emergence of the global COVID-19 pandemic prompted the declaration of a public health crisis, resulting in a substantial upheaval in conventional in-person education. In response to the challenges posed by the pandemic, there was an expeditious transition to online learning platforms as students encountered diverse obstacles in attending traditional face-to-face classes. Various considerations, such as apprehensions regarding students' auditory and visual well-being, played a pivotal role in the deliberation to persist with virtual learning modalities.

Online learning emerged as a pivotal solution, enabling students to seamlessly pursue their education amid the challenges posed by the pandemic. An array of online platforms surfaced, fostering connectivity between educators and learners, all from the comfort of their respective locations[1]. This was particularly crucial for schoolchildren, especially those in high and higher secondary levels, mandated to engage in virtual classes as part of their preparation for public examinations. Despite the manifold advantages of online learning, prolonged exposure to digital devices has given rise to specific health issues. Notable among these concerns are eye strain, ear problems, and various other digital-related issues that have become increasingly prevalent.

The results of our investigation revealed a noteworthy prevalence of digital eye strain, impacting 33.2% of the total participants. According to this analysis, 5.6% of people have significant digital eye strain and 27.6% have light strain. These findings are consistent with a study conducted in Saudi Arabia and found a similar pattern[9]. The majority of the study participants reported various symptoms connected to eye strain from digital devices. The most frequently reported symptoms were headache (48.88%), itchiness (36.78%), tearing (36.19%), eye tiredness (35.62%), burning sensation (35.07%), and intolerance to light at night (34.32%). These symptoms are consistent with findings from other studies on eye strain resulting from extended usage of digital devices.[4,10–13]

Table 4: Associated risk factors for digital eye strain

Factors	Digital Eye Strain			Chi-square value	P value
	Normal (%) (n=179*)	Mildly affected (%) (n=74*)	Moderately affected (%) (n=15*)		
Age					
13 (n=37)	21 (11.7)	13 (17.6)	3 (20)	18.203	0.020*
14 (n=80)	56 (31.3)	17 (23)	7 (46.7)		
15 (n=68)	49 (27.4)	15 (20.3)	4 (26.7)		
16 (n=72)	42 (23.5)	29 (39.2)	1 (6.7)		
17 (n=11)	11 (6.1)	0	0		
Sex					
Male (n=49)	35 (19.6)	9 (12.2)	5 (33.3)	4.323	0.115
Female (n=219)	144 (80.4)	65 (87.8)	10 (66.7)		
Class					
9 (n=61)	41 (22.9)	17 (23)	3 (19.7)	18.503	0.005
10 (n=87)	55 (30.7)	21 (28.4)	11 (10.3)		
12 (n=47)	38 (21.2)	9 (12.2)	0		
11 (n=73)	45 (25.1)	27 (36.5)	1 (6.7)		
Attending online					
Yes (n=142)	97 (54.2)	38 (51.4)	7 (46.7)	1.945	0.746
No (n=56)	37 (20.7)	17 (23)	2 (13.3)		
Sometime (n=70)	45 (25.1)	19 (25.7)	6 (40)		
Hours spent in online classes					
1 (n=116)	68 (38)	40 (54.1)	8 (53.3)	11.675	0.166
2 (n=64)	41 (22.9)	18 (24.3)	5 (33.3)		
3 (n=21)	17 (9.5)	4 (5.4)	0		
4 (n=22)	18 (10.1)	4 (5.4)	0		
5 (n=45)	35 (19.6)	8 (10.8)	2 (13.3)		
Type of devices used for learning					
Smart phone (n=247)	163 (91.1)	70 (94.56)	14 (93.3)	5.502	0.481
Laptop (n=16)	12 (6.7)	4 (5.4)	0		
Desktop (n=4)	3 (1.7)	0	1 (6.7)		
Tablet (n=1)	1 (0.6)	0	0		
Wearing specs					
Yes (n=52)	26 (14.5)	18 (24.3)	8 (53.3)	14.912	0.001*
No (n=216)	153 (85.5)	56 (75.7)	7 (46.7)		
Watch mobile other than class hours					
Yes (n=208)	134 (74.9)	60 (81.1)	14 (93.3)	3.727	0.444
No (n=60)	45 (25.2)	14 (18.9)	1 (6.7)		
How many hours do you spend apart from online classes					
1 (n=100)	74 (41.3)	16 (21.6)	10 (66.7)	23.457	0.009*
2 (n=58)	42 (23.5)	13 (17.6)	3 (20)		
3 (n=57)	33 (18.4)	23 (31.1)	1 (6.7)		
4 (n=20)	10 (5.6)	10 (13.5)	0		
5 (n=22)	14 (7.8)	7 (9.5)	1 (6.7)		
6 (n=11)	6 (3.4)	5 (6.8)	0		
Device distance while screening					
Nearby (n=59)	34 (19)	17 (23)	8 (53.3)	11.851	0.018*
Faraway (n=17)	14 (7.8)	2 (2.7)	1 (6.7)		
Normal distance (n=192)	131 (73.2)	55 (74.3)	6 (40)		
Wearing protective eyeglasses					
Yes (n=23)	12 (6.7)	10 (13.5)	1 (6.7)	3.169	0.205
No (n=245)	167 (93.3)	64 (86.5)	14 (93.3)		
Position while screening device					
Sitting (n=138)	84 (46.9)	43 (58.1)	11 (73.3)	6.715	0.348
Lying (n=20)	16 (8.9)	4 (5.4)	0		
Both (n=110)	79 (44.2)	27 (36.5)	4 (26.7)		
Device level of brightness					
10% (n=68)	41 (22.9)	25 (33.8)	2 (13.3)	7.526	0.481
30% (n=104)	71 (39.7)	26 (35.1)	7 (46.7)		
50% (n=74)	51 (28.5)	17 (23)	6 (40)		
70% (n=20)	14 (7.8)	6 (8.1)	0		
100% (n=2)	2 (1.1)	0	0		

*Normal – 179 (66.8%); Mildly affected – 74 (27.6%); Moderately affected – 15 (5.6%)

Table 5: Associated risk factors for digital auditory strain

Factor	Digital Auditory Strain			Chi-square value	P value
	Normal (%) (n=220*)	Mildly affected (%) (n=28*)	Moderate affected (%) (n=20*)		
Age					
13 (n=37)	30 (13.6)	4 (14.3)	3 (15)	18.381	0.019*
14 (n=80)	71 (32.3)	8 (28.6)	1 (5)		
15 (n=68)	57 (25.9)	8 (28.6)	3 (15)		
16 (n=72)	55 (25)	5 (17.9)	12 (60)		
17 (n=11)	7 (3.2)	3 (10.7)	1 (5)		
Sex					
Male (n=49)	32 (14.5)	8 (28.6)	9 (45)	13.596	0.001*
Female (n=219)	188 (85.5)	20 (71.4)	11 (55)		
Students' grade					
9 (n=61)	48 (21.8)	10 (35.7)	3 (15)	18.289	0.006*
10 (n=87)	76 (34.5)	10 (35.7)	1 (5)		
12 (n=47)	41 (18.6)	2 (7.1)	4 (20)		
11 (n=73)	55 (25)	6 (21.4)	12 (60)		
Attending online					
Yes (n=142)	112 (50.9)	16 (57.1)	14 (70)	6.397	0.171
No (n=56)	52 (23.6)	3 (10.7)	1 (5)		
Sometime (n=70)	56 (25.5)	9 (32.1)	5 (25)		
Using hearing Devices					
Yes (n=161)	125 (56.8)	20 (71.4)	16 (80)	4.157	0.125
No (n=107)	95 (43.1))	8 (28.5)	4 (20)		
Type of hearing devices used					
Headphone (n=88)	74 (33.6)	6 (21.4)	8 (40)	6.345	0.786
Ear Pods (n=50)	42 (19.01)	5 (17.9)	3 (15)		
Speakers (n=23)	17 (7.7)	5 (17.9)	1 (5)		
None of the above (n=107)	87 (39.54)	12 (42.8)	8 (40)		
Headphone usage in hours					
2 (n=176)	143 (65)	24 (85.7)	9 (45)	13.132	0.041*
2-4 (n=58)	49 (22.3)	2 (7.1)	7 (35)		
4-6 (n=11)	11 (5)	0	0		
6 (n=23)	17 (7.7)	2 (7.1)	4 (20)		
Frequency of Hearing					
Continuously (n=39)	26 (11.8)	6 (21.4)	7 (35)	17.901	0.001*
Intermittent (n=98)	87 (39.5)	3 (10.7)	8 (40)		
Occasionally (n=131)	107 (48.6)	19 (67.9)	5 (25)		
Increase in volume					
Yes (n=120)	98 (44.5)	12 (42.9)	10 (50)	2.562	0.634
No (n=106)	85 (38.6)	14 (50)	7 (35)		
Occasionally (n=42)	37 (16.8)	2 (7.1)	3 (15)		

*Normal – 220 (82.1%); Mildly affected – 28 (10.4%); Moderately affected – 20 (7.4%)

It was disclosed that 33.1% of students aged 3-18 exhibited mild eye strain, 20.8% experienced a moderated level, and 15.9% reported severe eye strain. With a mean age of 15.26, we found a statistically significant correlation with digital eye strain. This is consistent with research from Thailand that examined how COVID-19 affected children in grades 4 through 12, finding that 48.3% of individuals experienced mild to severe computer vision syndrome.[8] An even greater proportion of computer vision syndrome (76.1%) was found in another study conducted among Saudi Arabian teenagers.[11] One probable cause of the rising incidence of eye strain is the extended use of digital gadgets, especially by university and college students. There are differences between these age groups in terms of online class hours, digital-related homework or assignments, how often online notes are consulted, and how often electronic devices are used for non-learning activities. Furthermore, depending on their grade level, kid's learning pressure particularly for those getting ready for public exams may vary greatly, which might have an impact on their eye health in different ways. Due to the COVID-19 pandemic, traditional classrooms were replaced with virtual classrooms, which forced students to engage with electronic gadgets for extended durations.[1,4,6,14]

The duration of gadget usage specifically, using a device for entertainment, games, or other purposes for two to six hours per day was found to be statistically significantly correlated (p=0.009) with eye strain in the current study. Due to the pandemic, students are being forced to stay indoors in order to minimize infection risks. This has resulted in a more sedentary lifestyle and a greater reliance on technology for hobbies like gaming, watching movies, and texting pals. This result aligns with studies from Spain, Egypt, and India that demonstrate the detrimental impact of extended gadget use on ocular health.[15–17]

Most participants stated a preference for a nearby distance, and our research revealed a significant correlation (p=0.018) between eye strain and the proximity

of mobile device usage during and after online classes. Notably, prolonged device usage is a result of post-online class activities including note-taking and additional reading. A variety of variables, with differing effects at different distances usage of gadgets, were shown to be potential stressors on the ocular muscles when it came to school-related tasks, including font size and screen brightness. These findings underline the necessity to address not just the duration but also the spatial features of digital device use in minimizing eye strain, particularly within an educational setting.

The data revealed a noteworthy pattern that suggests those who wear spectacles are more likely to experience eye strain (p=0.001). This result is consistent with earlier research from Jeddah, Egypt, and India that found that students pursuing careers in the health professions and school-age children who wear spectacles are more likely to have digital eye strain.[18–20] Using electronics for extended periods of time can exacerbate symptoms of eye strain, especially in people who have refractive problems. The eyes' ongoing adaptation to digital screens may make refractive problems worse.

Notable cases of auditory strain associated with digital devices were also found in our study, affecting 17.9% of subjects. Based on this breakdown, 10.4% of respondents reported mild auditory strain, and 7.5% of participants suffering with significant auditory strain. This observation suggests a potential link between the participants' development of auditory strain and their constant use of audio devices such as speakers, earbuds, and headphones during online classes. The shift to online learning has necessitated increased reliance on these audio tools, potentially contributing to the reported levels of auditory strain.

Notable correlations between demographic characteristics and auditory strain associated with digital devices were found in the study. In particular, ear strain affected 16-year-old individuals more moderately (p=0.019) than participants in other age groups. Male students appear to be more susceptible to ear strain than female participants by a significant margin (p<0.001). Furthermore, compared to other grades, grade 11 children seem to be the most affected by ear strain (p=0.006). The preparation for a public exam, an increased workload, and ongoing online coursework for higher marks are a few academic pressure-related variables that could be responsible for the trends in ear strain among the respondents.

Our study found a strong correlation (p<0.05) between the use of headphones and auditory strain, with most participants using them to make online classes more convenient. The study also shows that individuals' use of headphones has caused ear discomfort associated with digital devices. The need to reduce outside distractions, obtain clear voice communication, and utilize devices more easily without bothering other family members are some of the reasons why people use headphones. Our findings do, however, point to a potential disadvantage because prolonged headphone use is associated with ear strains brought on by digital gadgets. This finding is consistent with a study done in India, where 9.4% of participants showed signs of being susceptible to both ear strain and possible hearing loss.[21]

Notably, there was a significant correlation (p<0.001) between the frequency of continuous headphone use and mild and moderate levels of digitally-related auditory strain. These results were consistent with those of an Iranian study.[22] Another study in France, concentrating on call dispatchers utilizing headsets, similarly observed auditory fatigue.[23] Ear strain may result from the loudness level of headphones as well as internal alterations in auditory waves caused by wearing them. In our study, we found that students who used headphones for more than three to six hours a day reported experiencing symptoms of auditory strain, including ear infections, ringing in the ears, exhaustion, and pain, particularly when using electronics.

This study provides crucial insights into the substantial impact about the significant effects of digital devices on school children's visual and auditory health. Proactive steps must be taken to safeguard against and stop potential health problems brought on by extended use of digital device. Comprehensive guidelines for online education should be formulated in light of these findings, with a primary focus on promoting students' health and preventing related difficulties.

Crafting guidelines for online education, encouraging educational institutions to collaborate with healthcare professionals to facilitate routine check-ups for visual and auditory health, educating and creating awareness among students, and adopting ergonomic practices to safeguard both visual and auditory well-being. It also recommended that students' eye and auditory health need to be examined regularly. Students need to be given awareness about the proper usage of gadgets for their learning purposes and to safeguard their health. Involving parents and educators is essential for promoting responsible digital device usage practices. These recommendations can bolster the demand for the execution of practical steps to safeguard students' health and well-being in the age of digital learning.

Conclusion

The pandemic has compelled students to heavily rely on online learning, exposing them to a range of digital-related challenges, particularly concerning visual and auditory strain. This study underscores the prevalence of such concerns among school students who engaged with digital devices for more than two hours daily, encompassing both educational and leisure activities. Notably, it was found that using headphones for longer than three hours was a major cause of auditory strain. Various elements, including the type of digital devices, the use of contact lenses, spectacles,

screen brightness, device distance, volume levels, and the type of hearing devices employed, were found to influence the risk of experiencing visual and auditory strains. The study emphasizes how important it is to conduct more research in order to gain deeper insights about health risks associated to digital devices.

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