Original Article

Association of screen time, quality of sleep and dry eye in college-going women of Northern India

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Purpose: To evaluate the association of daily screen time and quality of sleep with the prevalence of dry eye among college-going women. **Methods:** This study was a cross-sectional, comparative questionnaire-based study of 547 college-going women in northern India. A 10-item Mini Sleep Questionnaire was used to check the quality of sleep, and the Standard Patient Evaluation of Eye Dryness (SPEED) scale was used to examine the prevalence of dry eye among college-going women. **Results:** Multinomial logistic regression showed a significant association between dry eye with daily screen time spent ($P < 0.05$) and the quality of sleep ($P < 0.05$) among college-going girls. Using Latent Class Analysis, two latent classes were selected based on the Bayesian Information Criteria. It was found that the majority population falls in class two and was having Severe Sleep-Wake difficulty. It was seen that the participants in class two belonged to the age bracket of 18–21 years, were from stream Humanities, education of father and mother equal to graduation, father working only, belonging to the nuclear family, having one sibling, hailing from the urban locality, spending more than 6 h daily on-screen, a majority of them using mobile phones, not using eye lubricants, and reported an increase in screen time during COVID-19. **Conclusion:** Dry eye and sleep quality are essential global health issues, and coupled with increased screen time, may pose a challenge in the present era. Preventive strategies need to be incorporated in school and college curriculums to promote physical, social, and psychological well-being and quality of life.

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Computer vision syndrome has a prevalence of more than 50% among computer users.[1] An increase in websites and societal groups has enticed the youth to devote additional time to digital devices or computer monitor screens. Online education and entertainment platforms for gaming and movies are prevalent since the last decade. Consequently, there has been a constant upsurge in screen time for the youth in many countries.[1]

Several studies in the past have found an association between increased multimedia exposure and health issues. While there is substantial public understanding of the harmful effects of cellphone radiation, society is less aware of the additional consequences of increased screen time on well-being, leading to stress on the visual and musculoskeletal system, besides leading to circadian rhythm disturbances.

Circadian rhythm disturbances are due to the blue light emitted by these devices and the electromagnetic fields they produce.[2] Blue light leads to melatonin suppression which is a facilitator of sleep.[3,4] Computer-associated symptoms have been divided into two groups: those associated with the accommodation (blurring of vision while refocusing, headache, eye strain) and those linked to dry eyes (burning, grittiness, tearing, and dryness).[5] Dry eye from digital media use is produced due to decreased and incomplete blinks leading to an unstable tear film.[6]

Digital device use has increased during the COVID-19 pandemic as people were compelled to stay homebound, especially during nationwide lockdowns, to safeguard themselves from the deadly virus.[7] The main objective of this survey was to examine the association of daily screen time and the quality of sleep with the prevalence of dry eye among college-going women. Women were chosen as respondents in our study due to the higher prevalence of dry eye disease in females.[7–11]

Methods

The study was an exploratory and cross-sectional, comparative questionnaire-based study. The study was approved by the

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Institutional Ethics Committee and adhered to the tenets of the Helsinki Declaration. A pre-structured and pre-validated questionnaire was used to collect information on the prevalence of dry eye and quality of sleep. With the help of the snowball technique, the primary respondents, i.e., college-going girls in northern India, were contacted. The questionnaire was transcribed into a Google Form and provided to the participants through WhatsApp or Email. The survey was reported according to the Checklist for Reporting of Internet E-surveys (CHERRIES).[12] Informed consent was obtained from the participants preceding the study. Anonymity and confidentiality were maintained throughout the study. A 10-item Mini Sleep Questionnaire was used to check the quality of sleep,[13] and the Standard Patient Evaluation of Eye Dryness (SPEED)[14] dry eye scale was used to examine the prevalence of dry eye among college-going women. A few general questions were asked to review the screen time of the respondents. The reliability/consistency of the questionnaire was checked using Cronbach alpha. For the Mini Sleep Scale and dry eye scale, the Cronbach alpha was found to be 0.780 and 0.867, respectively, which indicates a good internal consistency and reliability. Hair *et al*. 2006[15] proposed that Cronbach alpha coefficient of 0.6 is acceptable, and it indicates internal reliability and consistency.

The questionnaire contains five domains

Demographic domain: This consisted of the demographic and socioeconomic details of the participants, namely age (18–21, 22–26, and 27–30 years); stream (Humanities, Science, and Commerce); education pursued to date (up to 12th, under graduation, post-graduation); education of the father (illiterate, up to 10th, up to 12th, graduate, post-graduate, doctorate/any other); education of the mother (illiterate, up to 10th, up to 12th, graduate, post-graduate, doctorate/any other); working status of parents (both working, only father working, only mother working); type of family (joint, nuclear [only parents and child]); the number of sibling (s) in the family (1, 2, 3, and more than 3); place of residence (urban, rural).

General question domain: This consisted of the following questions: Your daily screen time in the number of hours (0–2 h, 2–4 h, 4–6 h, and more than 6 h); Device on which maximum time spent (television, laptop/desktop, mobile phone and tablet/iPad); Mention the purpose of use of screen most of the time (social media, studies, movies, and gaming); Has your screen time increased during the COVID-19 pandemic? (Yes and No); If Yes, then by how much? (25, 25–50, 50–75, and 75–100%); Do you use eye drops for lubrication? (Yes and No).

Sleep-Wake Domain: The Mini Sleep Questionnaire consists of 10 items based on the 7-Point Likert Scale: difficulty falling asleep, waking up too early, hypnotic medication use, falling asleep during the day, feeling tired upon waking up in the morning, snoring, mid-sleep awakenings, headaches on awakening, excessive daytime sleepiness, excessive movement during sleep.

Dry Eye Domain: This domain consisted of the following items based on the SPEED questionnaire: frequency and severity of dryness, grittiness, or scratchiness, soreness or irritation, burning or watering, and eye fatigue symptoms

Creation of categories based on the grading of responses to the Sleep-Wake Domain and Dry Eye Domain

The responses to the Sleep-Wake Domain and Dry Eye Domain were graded to give a higher score for the options indicating more Sleep-Wake problems and frequency and severity of dry symptoms.

For each respondent, the sum of the responses for each domain was added and divided into categories. For the Sleep-Wake Domain, the respondents were divided into four categories[16]: 10–24 points for Good Sleep-Wake quality; 25–27 points for mild Sleep-Wake difficulties; 28–30 points for moderate Sleep-Wake difficulties; and >30 points for Severe Sleep-Wake difficulties. For the Dry Eye Domain, based on the score of the items on severity and frequency of the dry eye symptoms, the respondents were divided into three categories[14,17]: 0–5 (no symptoms), 6–14 (mild to moderate symptoms), and 15–28 (severe symptoms).

Development of dry eye assessment model

We established a multinomial logistic regression model for the prediction of the association of dry eye with daily screen time spent and the quality of sleep following the methodology described in the statistical analysis of the study.

Development of latent class models to identify the hidden cohort

We followed the methodology of the development of latent class described by Kumar-M *et al*.[18] It consisted of five steps: (1) selection of questions based on univariate analysis; (2) removal of questions with overlapping context; (3) addition of the selected questions to develop latent class model; (4) back exploration of the established latent class model for understanding the demographic pattern of the developed latent class model; (5) repetition of the process till a distinctive pattern is obtained.[18] Further, the number of hidden classes was identified after assessing the model diagnostics of the different number of classes. The Bayesian Information Criteria (BIC) was utilized for appraisal. The smaller the BIC, the superior the model.

Statistical analysis

A total of 547 respondents participated in the study. The data were recorded into an Excel sheet and analyzed using SPSS Version 20 and R version 4.0.4. In addition to the base package, the additional package used was gtsummary,[19] plyr,[20] readxl,[21] and poLCA[22] for conducting the Latent Class Analysis. The categorical variables were defined using frequencies along with percentages. For the evaluation of continuous variables between more than two groups, the Analysis of Variance was used, and for the comparison of categorical variables, the Chi-square test of association/Fisher's exact test was used. A *P* value of less than 0.05 was considered statistically significant for all the tests.

Results

In the present study, a total of 547 college-going girls in northern India agreed to participate. The overall demographic profile of the participants is shown in Table 1. The major characteristics of the participants were ages between 18 and 21 years (81.4%), a majority of the participants were from the Humanities stream (63.4%), studied up to graduation (79.7%), the education of father equal to graduation (36.9%), the education of mother equal to graduation (34.4%), having one sibling (57.4%), only father working (68.7%), hailing from the urban locality (79.7%), belonging to the nuclear family (60.3%), spending more than 6 h daily on-screen (45.5%).

Table 1: Description of demographics for overall and comparison of demographics between Sleep-Wake Domain and Dry Eyes domain

Characteristics		Overall*		Sleep-Wake Domain *P*	Dry Eyes domain *P*
		Count=547	Percent		
Age	18-21 years	445	81.40%	0.240***	0.925***
	22-26 years	99	18.10%		
	27-30 years	3	0.50%		
Stream	Humanities	347	63.40%	0.3002**	0.409**
	Sciences	109	19.90%		
	Commerce	91	16.60%		
Class	Up to 12th	5	0.90%	0.1028** Fisher's exact test	0.8409** Fisher's exact test
	Graduate	436	79.70%		
	Post-graduate	106	19.40%		
Education of father	Illiterate	11	2.00%	0.00278** Fisher's exact test	0.047**
	Up to 10th	37	6.80%		
	Up to 12th	96	17.60%		
	Graduate	202	36.90%		
	Post-graduate	154	28.20%		
	Doctorate/any other	47	8.60%		
Education of mother	Illiterate	17	3.10%	0.09916** Fisher's exact test	0.144**
	Up to 10th	56	10.20%		
	Up to 12th	103	18.80%		
	Graduate	188	34.40%		
	Post-graduate	157	28.70%		
	Doctorate/any other	26	4.80%		
Working status of parents	Both working	160	29.30%	0.08885** Fisher's exact test	0.8768** Fisher's exact test
	Only father working	376	68.70%		
	Only mother working	11	2.00%		
Type of family	Joint	217	39.70%	0.486**	0.611**
	Nuclear (only parents and child)	330	60.30%		
No. of siblings	1	314	57.40%	0.169**	0.623**
	2	152	27.80%		
	3	60	11.00%		
	More than 3	21	3.80%		
Place of residence	Urban	436	79.70%	0.033**	0.366**
	Rural	111	20.30%		
No. of hours daily time	0 to 2 h	21	3.80%	0.000***	0.000***
	2 to 4 h	95	17.40%		
	4 to 6 h	182	33.30%		
	More than 6 h	249	45.50%		

*Statistics presented: *n* (%). **Statistical tests performed: Chi-square test of independence; Fisher's exact test. ***Statistical tests performed: Analysis of Variance

Among the demographic factors for the Sleep-Wake Domain, education of father, place of residence, and the number of hours daily spent on-screen came as significant predictors in the univariate analysis. Similarly, among the demographic factors for the dry eye domain, the education of the father and the number of hours daily spent on-screen came as significant predictors in the univariate analysis.

The questionnaire provided to the girls is given in Supplementary Table 1, and the summary of the responses for individual questions for Sleep-Wake and dry eye domain are presented in Supplementary Table 2. The univariate analysis of the responses based on the Good Sleep-wake quality, Mild Sleep-Wake difficulty, Moderate Sleep-Wake difficulty, Severe Sleep-Wake difficulty in the Sleep-Wake Domain and no symptoms, mild to moderate symptoms, severe symptoms in the dry eyes domain are shown in Table 2.

Multinomial logistic regression was applied for the prediction of the association of the dry eye with the daily screen time spent and the quality of sleep among the respondents. As per the results, there was a significant association between dry eye with the daily screen time spent (P value = 0.00 <0.05) and the quality of sleep/Sleep-Wake (P value = 0.00 <0.05) among college-going women. Further, the power of the logistic multinomial model developed in the study was 58.86% of the

known observations and can be likely to design forthcoming estimations [Table 3].

With the help of the Latent Class Analysis, two latent classes were selected based on the BIC, where there was a significant difference between the two classes based on the Sleep-Wake Domain (having Good Sleep-wake quality, Mild Sleep-Wake difficulty, Moderate Sleep-Wake difficulty, Severe Sleep-Wake difficulty) [Table 4]. Further, it was found that the majority of the population falls in class two and was having Severe Sleep-Wake difficulty. On further exploring the characteristics between the two classes, it was found that the participants in class two

Table 2: Description of responses for General Domain and comparison of responses between Sleep-Wake Domain and Dry Eyes Domain

Statements	Responses	Overall*		Sleep-Wake Domain *P*	Dry Eyes Domain *P*
		Count=547	Percent		
Device on which maximum time spent	Television	17	3.10%	0.7844** Fisher's exact test	0.01053** Fisher's exact test
	Laptop/Desktop	97	17.70%		
	Mobile Phone	425	77.70%		
	Tablet/iPad	8	1.50%		
Purpose	Social media	160	29.30%	0.02427** Fisher's exact test	0.021**
	Studies	333	60.90%		
	Movies	38	6.90%		
	Gaming	16	2.90%		
Increase in screen time	No	30	5.50%	0.000** Fisher's exact test	0.001**
	Yes	517	94.50%		
How much increase	25%	58	11.20%	0.000**	0.001**
	25-50%	153	29.70%		
	50-75%	222	43.00%		
	75-100%	83	16.10%		
Use of eye drops	No	449	82.10%	0.853**	0.000**
	Yes	98	17.90%		
Dry eyes system reported	No symptom reported	70	12.80%	0.000**	0.000**
	Symptoms reported	477	87.20%		
Sleep-wake	Good Sleep-Wake quality	110	20.1%		0.00**
	Mild Sleep-Wake difficulty	48	8.8%		
	Moderate Sleep-Wake difficulty	55	10.1%		
	Severe Sleep-Wake difficulty	334	61.1%		
Dry eye	Mild dry eye	130	23.8%	0.00**	
	Moderate dry eye	94	17.2%		
	Severe dry eye	323	59.0%		

*Statistics presented: *n* (%). **Statistical tests performed: Chi-square test of independence; Fisher's exact test

Table 3a: Association of dry eye with number of hours spent on screen and quality of sleep (sleep-wake)

Effect	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood of Reduced Model	Chi-square	df	Sig.
Intercept	119.719[a]	0.000	0	
No. of hours daily time	136.908	17.189	2	0.000
Sleep-wake	188.741	69.021	6	0.000

Table 3b: Classification of dry eye based on the developed regression model

Observed	Predicted			
	No Symptoms	Mild to Moderate Symptoms	Severe Symptoms	Percent Correct
No symptoms	127	91	0	58.3%
Mild to moderate symptoms	63	195	0	75.6%
Severe symptoms	6	65	0	0.0%
Overall percentage	35.8%	64.2%	0.0%	58.9%

Table 4: Descriptive characteristics of the selected model

Characteristics		Class 1*		Class 2*		*P***
		Count=267	Percent	Count=280	Percent	
Age	18-21 years	206	77.15	239	85.36	0.02536 Fisher's exact test
	22-26 years	59	22.1	40	14.29	
	27-30 years	2	0.749	1	0.357	
Stream	Humanities	164	61.42	183	65.36	0.01005
	Sciences	46	17.23	63	22.5	
	Commerce	57	21.35	34	12.14	
Class	Up to 12th	2	0.749	3	1.071	0.697
	Graduate	210	78.65	226	80.71	
	Post-graduate	55	20.6	51	18.21	
Education of father	Illiterate	10	3.745	1	0.357	0.00
	Up to 10th	37	13.86	0	0	
	Up to 12th	94	35.21	2	0.714	
	Graduate	113	42.32	89	31.79	
	Post-graduate	12	4.494	142	50.71	
	Doctorate/any other	1	0.375	46	16.43	
Education of mother	Illiterate	17	6.367	0	0	0.00
	Up to 10th	56	20.97	0	0	
	Up to 12th	98	36.7	5	1.786	
	Graduate	90	33.71	98	35	
	Post-graduate	6	2.247	151	53.93	
	Doctorate/any other	0	0	26	9.286	
Working status of parents	Both working	28	10.49	132	47.14	0.00
	Only father working	233	87.27	143	51.07	
	Only mother working	6	2.247	5	1.786	
Type of family	Joint	129	48.31	88	31.43	0.00
	Nuclear (only parents and child)	138	51.69	192	68.57	
No of siblings	1	119	44.57	195	69.64	0.00
	2	88	32.96	64	22.86	
	3	42	15.73	18	6.429	
	More	18	6.742	3	1.071	
Place of residence	Urban	178	66.67	258	92.14	0.00
	Rural	89	33.33	22	7.857	
No of hours daily time	0-2 h	15	5.618	6	2.143	0.001841
	2-4 h	58	21.72	37	13.21	
	4-6 h	90	33.71	92	32.86	
	More than 6 h	104	38.95	145	51.79	
Device on which maximum time spent	Television	13	4.869	4	1.429	0.00
	Laptop/Desktop	30	11.24	67	23.93	
	Mobile Phone	224	83.9	201	71.79	
	Tablet/iPad	0	0	8	2.857	
Purpose	Social media	82	30.71	78	27.86	0.07754
	Studies	161	60.3	172	61.43	
	Movies	21	7.865	17	6.071	
	Gaming	3	1.124	13	4.643	
Increase in screen time	No	22	8.24	8	2.857	0.009996
	Yes	245	91.76	272	97.14	
Use of eye drops	No	230	86.14	219	78.21	0.02115
	Yes	37	13.86	61	21.79	

Contd...

Table 4: Contd...

Characteristics		Class 1*		Class 2*		P**
		Count=267	Percent	Count=280	Percent	
Sleep-wake	Good Sleep-wake quality	57	21.35	53	18.93	0.005743
	Mild Sleep-Wake difficulty	28	10.49	20	7.143	
	Moderate Sleep-Wake difficulty	15	5.618	40	14.29	
	Severe Sleep-Wake difficulty	167	62.55	167	59.64	
Dry Eye	Mild dry eye	103	38.58	115	41.07	0.6818
	Moderate dry eye	131	49.06	127	45.36	
	Severe dry eye	33	12.36	38	13.57	

belonged to the age bracket of 18–21 years, a majority of them were from the Humanities stream, education of father and mother equal to graduation, only father working, belonging to the nuclear family, having one sibling, hailing from the urban locality, spending more than 6 h daily on-screen, a majority of them using mobile phones, not using eye lubricants, and reported an increase in screen time during COVID-19.

Discussion

Increased digital device use for professional and social causes is considered a new normal these days. Studies have documented that odds of an unhealthy lifestyle and subjective complaints increase with the use of electronic media beyond 1 h.[23] These ill effects on the health/lifestyle include depression and anxiety,[24] sedentary behavior and obesity,[25] headache, neck/shoulder pain, backache,[1,26,27] shorter sleep duration,[28] and dry eye.[27]

In our study, out of the 547 total respondents, 425 respondents (77.7%) were spending maximum time on mobile phones, and out of these, 47.06% of the respondents were facing mild-moderate dry eyes symptoms. The purpose of screen use for 60.9% of the total respondents was studying. However, 66.37% of these respondents were facing Severe Sleep-Wake difficulties. Moreover, 94.5% of the participants mentioned that their screen time had increased during the COVID-19 pandemic, and out of these, 63.24% reported Severe Sleep-Wake difficulties, and 48.16% were having mild-moderate dry eyes symptoms. In a recent review, 90% of the studies found an association between screen use and late bedtime and/or diminished total sleep time.[28] The prevalence of poor sleep quality was 37.94% among 5,233 Chinese college students in another study. High screen time and less physical activity were significantly associated with suboptimal physiological, psychological/mental, social health, and poor sleep quality.[29,30] A greater screen time has been significantly associated with an increased dietary intake of sugary drinks, fast foods, and bakery items.[31]

In our study, for 43% of the participants, the screen time had reportedly increased during COVID-19 by 50–75%. Bahkir *et al*.[7] reported an average increase of screen time by 5 h during the pandemic in 51.1% of their study respondents.

Further, in our analysis, 87.2% of the participants mentioned dry eye symptoms, and out of these, 53.24 and 14.46% were facing mild/moderate dry eyes and severe dry symptoms, respectively. In another study, 94 medical students using smartphones for over a year and without pre-existing dry eye disease or ocular surface pathology were included. A statistically significant escalation in the dry eye disease symptom score and the prevalence of computer vision syndrome symptoms with increasing duration of use and daily exposure to smartphones was found.[32]

Most importantly, 65.61% of the women who reported dry eye symptoms had Severe Sleep-Wake difficulties. In some studies, it is anticipated that more than 40% of people with dry eye have sleep disorders.[33,34] In a questionnaire-based study of 3,070 participants, the subjects with sleep anomalies had an augmented probability of dry eye severity.[35] Lee *et al*.[36] demonstrated that lack of sleep increased the tear osmolarity, reduced the tear film break-up time, and lessened the tear secretions, each one of which independently triggered or exacerbated the ocular surface disease. Sleep ailments have a propensity to be linked with autonomic dysfunction that affects the parasympathetic fibers in the lacrimal glands, resulting in decreased tear secretions. Sleep loss generates a buildup of lipids and lacrimal gland dysfunction. It decreases endogenous lipid palmitoylethanolamide (PEA) expression in the lacrimal glands which are responsible for the homeostasis of lipid metabolism.[37]

Sleep helps in memory consolidation.[38] Sleep deprivation and poor sleep quality can pose a challenge to college students and can lead to lesser academic scores, impaired learning, and an augmented menace of vehicular accidents.[39] According to a study in Korea, individuals having a sleeping length lesser than 5 h were found to have 20% increased chances of suffering from dry eye in comparison to those people with more than 6 h of sleep duration.[40]

We need to focus on sleep-friendly screen-behavior recommendations for the youths worldwide. These include limiting screen time to 30–60 min before bedtime, restricting all digital devices from the bedrooms, and avoiding snacking on fast foods and sugars.[28,31] Dry eyes associated with digital device use need to be addressed by promoting complete, frequent, and forceful blinks, which can help release lipids from the meibomian gland leading to amelioration of the evaporative dry eye. Preservative-free lubricant eye drops and proper screen positioning of 4–5 inches below eye level to decrease ocular surface evaporation can be employed. Frequent pauses during screen use using customized Apps[41] or the 20-20-20 rule (to focus on a distance of 20 feet every 20 min for 20 s), utilizing small plus powered computer glasses to relax accommodation are other modalities to lessen eye strain. To minimize the circadian rhythm disturbances affecting sleep, blue light filtering (yellow tinted) glasses can be worn.[1,42]

The strength of our study lies in the fact that this is the first largest single-gender community-based study evaluating the connection between screen time, sleep quality, and dry eye, as well as multiple elements of sleep quality with a high response rate. The self-reported assessment of symptoms and quality through questionnaires may be considered complementary to objective examination findings documented in other studies. Moreover, we focused on the life quality and the self-assessment of the disease variables themselves, which might have more weightage than clinical evaluations.

The limitations of our study include the following: first, the cross-sectional nature of our study limits the establishment of a temporal relation between screen time, sleep, and dry eye. Second, recall and misclassification bias is possible in questionnaire-based studies. Third, snowballing being a non-random sampling technique of data collection, can contribute to selection/sampling bias as new participants may be recruited from their circle of acquaintances.[43]

Conclusion

To conclude, dry eye and sleep quality are essential global health issues, and coupled with increased screen time, may pose a challenge in the present era. Preventive strategies need to be incorporated in school and college curriculums to promote physical, social, and psychological well-being and quality of life.

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Conflicts of interest

There are no conflicts of interest.

References

1. Sheppard AL, Wolffsohn JS. Digital eye strain: Prevalence, measurement and amelioration. BMJ Open Ophthalmol 2018;3:e000146.
2. Patil A, Bhavya, Chaudhury S, Srivastava S. Eyeing computer vision syndrome: Awareness, knowledge, and its impact on sleep quality among medical students. Ind Psychiatry J 2019;28:68–74.
3. Cajochen C, Kräuchi K, Wirz-Justice A. Role of melatonin in the regulation of human circadian rhythms and sleep. J Neuroendocrinol 2003;15:432–7.
4. Figueiro MG, Wood B, Plitnick B, Rea MS. The impact of light from computer monitors on melatonin levels in college students. Neuro Endocrinol Lett 2011;32:158–63.
5. Sheedy JE, Hayes JN, Engle J. Is all asthenopia the same? Optom Vis Sci Off Publ Am Acad Optom 2003;80:732–9.
6. Hirota M, Uozato H, Kawamorita T, Shibata Y, Yamamoto S. Effect of incomplete blinking on tear film stability. Optom Vis Sci 2013;90:650–7.
7. Bahkir F, Grandee S. Impact of the COVID-19 lockdown on digital device-related ocular health. Indian J Ophthalmol 2020;68:2378-83.
8. Guillon M, Maïssa C. Tear film evaporation--effect of age and gender. Contact Lens Anterior Eye J Br Contact Lens Assoc 2010;33:171–5.
9. Courtin R, Pereira B, Naughton G, Chamoux A, Chiambaretta F, Lanhers C, *et al*. Prevalence of dry eye disease in visual display terminal workers: A systematic review and meta-analysis. BMJ Open 2016;6:e009675.
10. Matossian C, McDonald M, Donaldson KE, Nichols KK, MacIver S, Gupta PK. Dry eye disease: Consideration for women's health. J Womens Health 2019;28:502–14.
11. Shah S, Jani H. Prevalence and associated factors of dry eye: Our experience in patients above 40 years of age at a Tertiary Care Center. Oman J Ophthalmol 2015;8:151-6.
12. Eysenbach G. Improving the quality of web surveys: The Checklist for Reporting Results of Internet E-Surveys (CHERRIES). J Med Internet Res 2004;6:e34.
13. V, I., J, S., & O, C. (2018). A survey on sleep assessment methods. PeerJ, 6(5). https://doi.org/10.7717/PEERJ.4849.
14. Ngo W, Situ P, Keir N, Korb D, Blackie C, Simpson T. Psychometric properties and validation of the standard patient evaluation of eye dryness questionnaire. Cornea 2013;32:1204–10.
15. Hair JF, Black WC, Babin BJ, Anderson RE, Tatham RL.Multivariate data analysis (Vol. 6). Upper Saddle River, NJ: Pearson Prentice Hall 2006.
16. Natale V, Fabbri M, Tonetti L, Martoni M. Psychometric goodness of the Mini Sleep Questionnaire. Psychiatry and Clinical Neurosciences 2014;68:568-73.
17. Asiedu K. Rasch Analysis of the standard patient evaluation of eye dryness questionnaire. Eye Contact Lens 2017;43:394–8.
18. Kumar MP, Mahajan R, Kathirvel S, Hegde N, Kakkar AK, Patil AN. Developing a Latent Class Analysis model to identify at-risk populations among people using medicine without prescription. Expert Rev Clin Pharmacol 2020;13:1411–22.
19. Sjoberg DD, Curry M, Hannum M, Larmarange J, Whiting K, Zabor EC, *et al*. gtsummary: Presentation-ready data summary and analytic result tables. 2021. Available from: https://CRAN.R-project.org/package=gtsummary. [Last accessed on 2021 Apr 18].
20. Wickham H. The split-apply-combine strategy for data analysis. J Stat Softw 2011;40:1–29.
21. Wickham HBJ (n.d.). Copyright holder of all R code and all C code without explicit copyright, et al. Readxl: Read Excel Files. 2019. Retrieved November 28, 2020, from https://cran.r-project.org/package=readxl.
22. Beath KJ. randomLCA: An R package for latent class with random effects analysis. J Stat Softw 2017;81:1–25.
23. Mundy LK, Canterford L, Hoq M, Olds T, Moreno-Betancur M, Sawyer S, *et al*. Electronic media use and academic performance in late childhood: A longitudinal study. PLoS One 2020;15:e0237908.
24. Zink J, Belcher BR, Imm K, Leventhal AM. The relationship between screen-based sedentary behaviors and symptoms of depression and anxiety in youth: A systematic review of moderating variables. BMC Public Health 2020;20:472.
25. Mitchell JA, Rodriguez D, Schmitz KH, Audrain-McGovern J. Greater screen time is associated with adolescent obesity: A longitudinal study of the BMI distribution from ages 14 to 18. Obes Silver Spring Md 2013;21:572–5.
26. Wong CW, Tsai A, Jonas JB, Ohno-Matsui K, Chen J, Ang M, *et al*. Digital screen time during the COVID-19 pandemic: Risk for a further myopia boom? Am J Ophthalmol 2021;223:333–7.
27. Portello JK, Rosenfield M, Bababekova Y, Estrada JM, Leon A. Computer-related visual symptoms in office workers. Ophthalmic Physiol Opt J Br Coll Ophthalmic Opt Optom 2012;32:375–82.
28. Hale L, Kirschen GW, LeBourgeois MK, Gradisar M, Garrison MM, Montgomery-Downs H, *et al*. Youth screen media habits and sleep: Sleep-friendly screen behavior recommendations for clinicians, educators, and parents. Child Adolesc Psychiatr Clin N Am 2018;27:229–45.
29. Ma C, Zhou L, Xu W, Ma S, Wang Y. Associations of physical activity and screen time with suboptimal health status and sleep quality among Chinese college freshmen: A cross-sectional study. PLoS One 2020;15:e0239429.

30. Wu X, Tao S, Zhang Y, Zhang S, Tao F. Low physical activity and high screen time can increase the risks of mental health problems and poor sleep quality among Chinese college students. PLoS One 2015;10:e0119607.
31. Al-Hazzaa HM, Al-Sobayel HI, Abahussain NA, Qahwaji DM, Alahmadi MA, Musaiger AO. Association of dietary habits with levels of physical activity and screen time among adolescents living in Saudi Arabia. J Hum Nutr Diet 2014;27(Suppl 2):204–13.
32. Faruqui S, Agarwal R, Kumar R. A study of the correlation between smartphone usage and dry eye in medical students at a tertiary care center. Trop J Ophthalmol Otolaryngol 2020;5:174-82.
33. Kawashima M, Uchino M, Yokoi N, Uchino Y, Dogru M, Komuro A, *et al*. The association of sleep quality with dry eye disease: The Osaka study. Clin Ophthalmol Auckl NZ 2016;10:1015–21.
34. Ayaki M, Kawashima M, Negishi K, Tsubota K. High prevalence of sleep and mood disorders in dry eye patients: Survey of 1,000 eye clinic visitors. Neuropsychiatr Dis Treat 2015;11:889–94.
35. Yu X, Guo H, Liu X, Wang G, Min Y, Chen SS, *et al*. Dry eye and sleep quality: a large community-based study in Hangzhou. Sleep 2019;42:zsz160. doi: 10.1093/sleep/zsz160. PMID: 31310315.
36. Lee YB, Koh JW, Hyon JY, Wee WR, Kim JJ, Shin YJ. Sleep deprivation reduces tear secretion and impairs the tear film. Invest Ophthalmol Vis Sci 2014;55:3525–31.
37. Chen Q, Ji C, Zheng R, Yang L, Ren J, Li Y, *et al*. N-palmitoylethanolamine maintains local lipid homeostasis to relieve sleep deprivation-induced dry eye syndrome. Front Pharmacol 2019;10:1622.
38. Hennies N, Lambon Ralph MA, Kempkes M, Cousins JN, Lewis PA. Sleep spindle density predicts the effect of prior knowledge on memory consolidation. J Neurosci Off J Soc Neurosci 2016;36:3799–810.
39. Hershner SD, Chervin RD. Causes and consequences of sleepiness among college students. Nat Sci Sleep 2014;6:73–84.
40. Lee W, Lim S-S, Won J-U, Roh J, Lee J-H, Seok H, *et al*. The association between sleep duration and dry eye syndrome among Korean adults. Sleep Med 2015;16:1327–31.
41. Slijper HP, Richter JM, Smeets JBJ, Frens MA. The effects of pause software on the temporal characteristics of computer use. Ergonomics 2007;50:178–91.
42. Loh K, Redd S. Understanding and preventing computer vision syndrome. Malays Fam Physician Off J Acad Fam Physicians Malays 2008;3:128–30.
43. Kirchherr J, Charles K. Enhancing the sample diversity of snowball samples: Recommendations from a research project on anti-dam movements in Southeast Asia. PLoS One 2018;13:e0201710.

Supplementary Table 1: Association of Screen time, Sleep and Dry Eye in college-going girls in northern India

A. Basic Information

1. Age
   a. 18–21 years
   b. 22–26 years
   c. 27–30 years
2. Stream
   a. Humanities
   b. Sciences
   c. Commerce
3. Class
   a. Up to 12th
   b. Graduate
   c. Post-graduate
4. Education of father
   a. Illiterate
   b. Up to 10th
   c. Up to 12th
   d. Graduate
   e. Post-graduate
   f. Doctorate/any other
5. Education of mother
   a. Illiterate
   b. Up to 10th
   c. Up to 12th
   d. Graduate
   e. Post-graduate
   f. Doctorate/any other
6. Working status of parents
   a. Both working
   b. Only father working
   c. Only mother working
7. Type of family
   a. Joint
   b. Nuclear (only parents and child)
8. No. of siblings
   a. 1
   b. 2
   c. 3
   d. More than 3
9. Place of residence
   a. Urban
   b. Rural
   c. Inadvertently

B. Screen-time Review

10. No. of hours daily time
    a. 0–2 h
    b. 2–4 h
    c. 4–6 h
    d. More than 6 h
11. Device on which maximum time spent
    a. Television
    b. Laptop/Desktop
    c. Mobile Phone
    d. Tablet/iPad

12. Purpose
    a. Social media
    b. Studies
    c. Movies
    d. Gaming

13. Increase in screen time
    a. No
    b. Yes

14. How much increase
    a. 25%
    b. 25–50%
    c. 50–75%
    d. 75–100%

C. Mini Sleep Questionnaire

15. Difficulty in falling asleep
    a. Never
    b. Very rarely
    c. Rarely
    d. Sometimes
    e. Often
    f. Very often
    g. Always

16. Waking up too early
    a. Never
    b. Very rarely
    c. Rarely
    d. Sometimes
    e. Often
    f. Very often
    g. Always

17. Hypnotic medication use
    a) Never
    b) Very rarely
    c) Rarely
    d) Sometimes
    e) Often
    f) Very often
    g) Always

18. Falling asleep during the day
    a) Never
    b) Very rarely
    c) Rarely
    d) Sometimes
    e) Often
    f) Very often
    g) Always

19. Feeling tired upon waking up in the morning
    a) Never
    b) Very rarely
    c) Rarely
    d) Sometimes
    e) Often
    f) Very often
    g) Always

20. Snoring
    a. Never
    b. Very rarely
    c. Rarely
    d. Sometimes
    e. Often
    f. Very often
    g. Always

21. Mid-sleep awakenings
    a. Never
    b. Very rarely
    c. Rarely
    d. Sometimes
    e. Often
    f. Very often
    g. Always

22. Headaches on awakening
    a. Never
    b. Very rarely
    c. Rarely
    d. Sometimes
    e. Often
    f. Very often
    g. Always

23. Excessive daytime sleepiness
    a. Never
    b. Very rarely
    c. Rarely
    d. Sometimes
    e. Often
    f. Very often
    g. Always

24. Excessive movement during the sleep
    a. Never
    b. Very rarely
    c. Rarely
    d. Sometimes
    e. Often
    f. Very often
    g. Always

D. Eye Dryness

25. Report the type of symptoms you experience within the last 3 months

	Yes	No
Dryness, grittiness, or scratchiness		
Soreness or irritation		
Burning or watering		
Eye fatigue		

26. Report the frequency of your symptoms in the eye using the list mentioned. 0 = Never, 1 = Sometimes, 2 = often, 3 = Constant

	0	1	2	3
Dryness, grittiness, or scratchiness				
Soreness or irritation				
Burning or watering				
Eye fatigue				

27. Report the severity of your symptoms using the list mentioned. 0 = no problem, 1 = tolerable–not perfect but not uncomfortable, 2 = uncomfortable–irritating but does not interfere with my day, 3 = bothersome–irritating, interferes with my day, 4 = intolerable–unable to perform my daily tasks

	0	1	2	3	4
Dryness, grittiness, or scratchiness					
Soreness or irritation					
Burning or watering					
Eye fatigue					

28. Do you use eye drops for lubrication?
    a.) Yes
    b.) No

Supplementary Table 2

Item-wise analysis of Sleep-wake Domain and comparison of responses based on Dry eye Domain

Statements	Responses	Never	Very Rarely	Rarely	Sometimes	Often	Very Often	Always	Dry Eyes Domain *P*
Difficulty in falling asleep	Count	49	46	68	192	68	64	60	0.000**
	Table *n* %	9.00%	8.40%	12.40%	35.10%	12.40%	11.70%	11.00%	
Waking up too early	Count	64	49	92	166	68	39	69	0.004**
	Table *n* %	11.70%	9.00%	16.80%	30.30%	12.40%	7.10%	12.60%	
Hypnotic medication use	Count	380	30	49	55	17	6	10	0.1007**
	Table *n* %	69.50%	5.50%	9.00%	10.10%	3.10%	1.10%	1.80%	Fisher's exact test
Falling asleep during the day	Count	71	84	97	149	47	61	38	0.022**
	Table *n* %	13.00%	15.40%	17.70%	27.20%	8.60%	11.20%	6.90%	
Feeling tired upon waking up in the morning	Count	63	48	54	128	85	63	106	0.000**
	Table *n* %	11.50%	8.80%	9.90%	23.40%	15.50%	11.50%	19.40%	
Snoring	Count	274	67	58	82	25	23	18	0.000**
	Table *n* %	50.10%	12.20%	10.60%	15.00%	4.60%	4.20%	3.30%	
Mid-sleep awakenings	Count	99	90	87	127	59	44	41	0.000**
	Table N %	18.10%	16.50%	15.90%	23.20%	10.80%	8.00%	7.50%	
Headaches on awakening	Count	146	95	54	117	58	43	34	0.000**
	Table *n* %	26.70%	17.40%	9.90%	21.40%	10.60%	7.90%	6.20%	
Excessive daytime sleepiness	Count	123	83	90	131	54	45	21	0.000**
	Table *n* %	22.50%	15.20%	16.50%	23.90%	9.90%	8.20%	3.80%	
Excessive movement during the sleep	Count	119	87	98	100	68	30	45	0.000**
	Table *n* %	21.80%	15.90%	17.90%	18.30%	12.40%	5.50%	8.20%	

Item-wise analysis of Dry eye Domain and comparison of responses based on Sleep-wake Domain

Frequency of symptoms

Statements	Responses	Never	Sometimes	Often	Constant	Sleep-wake Domain *P*
Dryness, grittiness, or scratchiness	Count	224	203	94	26	0.000**
	Table *n* %	41.00%	37.10%	17.20%	4.80%	
Soreness or irritation	Count	233	193	91	30	0.000**
	Table *n* %	42.60%	35.30%	16.60%	5.50%	
Burning or watering	Count	202	168	129	48	0.000**
	Table *n* %	36.90%	30.70%	23.60%	8.80%	
Eye fatigue	Count	165	164	147	71	0.000**
	Table *n* %	30.20%	30.00%	26.90%	13.00%	

Severity of symptoms

Statements	Responses	No problem	Tolerable-not perfect but uncomfortable	Uncomfortable-irritating but does not interfere with my day	Bothersome-irritating, interferes with my day	Intolerable-unable to perform my daily tasks	Sleep-Wake Domain *P*
Dryness, grittiness, or scratchiness	Count	259	183	67	28	10	0.002816** Fisher's exact test
	Table *n* %	47.30%	33.50%	12.20%	5.10%	1.80%	
Soreness or irritation	Count	246	173	89	31	8	0.000** Fisher's exact test
	Table *n* %	45.00%	31.60%	16.30%	5.70%	1.50%	
Burning or watering	Count	212	179	100	44	12	0.000** Fisher's exact test
	Table *n* %	38.80%	32.70%	18.30%	8.00%	2.20%	
Eye fatigue	Count	183	179	115	53	17	0.000** Fisher's exact test
	Table *n* %	33.50%	32.70%	21.00%	9.70%	3.10%	

**Statistical tests performed: Chi-square test of independence; Fisher's exact test