Assessment of Risk Factors for Dry Eye Disease Among Doctors in South India During the COVID-19 Pandemic: An Online Survey and Review of Literature

Ramya Chelliah[1], Kavya Nidhi[2], Helen Dhatchayani[1], Ravikumar Rangasamy[1], Sheela Ramani[1], Roy Arokiam Daniel[3], Karthikeyan Mahalingam[4]

[1]Department of Ophthalmology, Tagore Medical College and Hospital, Tamil Nadu, India; [2]Department of Ophthalmology, St John's Medical College and Hospital, Bengaluru, India; [3]Centre for Community Medicine, AIIMS, New Delhi, India; [4]Department of Ophthalmology, JIPMER, Puducherry, India

Abstract

Introduction: During the COVID-19 pandemic, apart from the usual risk factors, the usage of face masks along with an increase in screen time leads to dry eye and irritation. We planned to assess the prevalence of dry eye among doctors and the risk factors associated with it.

Methodology: A cross-sectional online survey was conducted amongst doctors practicing in Chennai, Tamil Nadu. A semi-structured, pre-tested questionnaire was given to the participants using Google Forms. The survey had the following sections: demographic data, systemic illness, workplace, type of mask with the duration of use, duration of screen time, and Ocular Surface Disease Index (OSDI) questionnaire.

Results: The mean age of the participants was 33.3±9.7 years. Based on OSDI 30.6%(n=64) had Dry eye disease (DED) [14.8% mild, 9.1% moderate, and 6.7% severe]. Univariate and multivariate logistic regression analysis showed the presence of air leak from mask to eyes during exhalation increased the odds of having DED by 2.2 times and history of DED (before the COVID-19 pandemic) also increased the odds by 2.3 times

Conclusion: There is a higher rate of prevalence of DED among doctors during the COVID-19 pandemic with the presence of air leak from mask as a modifiable risk factor.

Keywords: COVID-19, Dry Eye Disease, Screen Time

INTRODUCTION

The outbreak of coronavirus disease 2019 (COVID-19) started in December 2019 in Wuhan, China.[1] Later it spread all over the world and the World Health Organization (WHO) declared COVID-19 as a pandemic on 11 March 2020.[2] It is a highly infectious disease transmitted from human to human mainly through respiratory droplets while coughing, sneezing, or talking.[3,4] The first physician who was known to be in contact with the COVID-19 patient died later due to the same disease.[5] So while treating COVID-19 patients, the use of personal protective equipment is mandatory for frontline healthcare workers.[6–8] The use of face masks by healthcare workers and the public has become ubiquitous even in the absence of known COVID-19 patients.[9–11] Multiple measures like social distancing, handwashing, lockdown, and online schooling have been in force to control COVID-19 transmission. Concerning doctors (practicing academic institutes/ hospitals), an increase in video-tele consultations, change of physical theory classes, conferences/ continuing medical education to online made a significant increase in their screen time.[12–14]

Dry eye disease (DED) is a multifactorial disease of the ocular surface characterized by a loss of homeostasis of the tear film and accompanied by ocular symptoms, in which tear film instability and hyperosmolarity, ocular surface inflammation and damage, and neurosensory abnormalities play etiological roles.[15,16] Symptoms of

***Corresponding author:**
Karthikeyan Mahalingam MD, Department of Ophthalmology, Jawaharlal Institute of Postgraduate Medical Education and Research, Puducherry, India
E-mail: kalingachit@gmail.com

DED include dryness, pain, itching, and foreign body sensation.[17] It can be diagnosed with the following questionnaires: Ocular Surface Disease Index (OSDI), Dry Eye Questionnaire – 5 items (DED-5), McMonnies Questionnaire (MQ), Saliabury Eye Evaluation Questionnaire (SEEQ), etc.[18,19] The risk factors for DED include female gender, older age, androgen insufficiency, post-menopausal estrogen treatment, collagen vascular disease, antihistamines, contact lens use, refractive surgery, etc.[20,21] We have been noticing an increase in symptoms of DED among the public and also in the doctors during this pandemic. Recent studies suggest that during COVID-19 pandemic, apart from the usual risk factors, the usage of face masks (Mask Associated Dry Eye -MADE) along with an increase in screen time leads to dry eye and irritation.[22–26] As in doctors, there is both an increase in the use of face masks and an increase in screen time, this study was planned to assess the prevalence of dry eye among doctors and the risk factors associated with it.

METHODOLOGY

This is a cross-sectional online survey conducted amongst doctors practicing in Chennai, Tamil Nadu after obtaining ethical committee clearance. A semi-structured, pre-tested self-administered questionnaire was given to the participants using Google Forms. The Google forms were circulated through social media like WhatsApp, E-mail, Facebook, and Telegram. The participants can answer the questions in Google form only after giving their consent for the study. The survey had the following sections: demographic data, systemic illness, workplace, type of mask with the duration of use, duration of screen time, and OSDI questionnaire.

OSDI: Has 3 subscales with a total of 12 questions with 5 options (score 0 to 4).[27] The final score is calculated by (sum of all scores) * 25 / (number of questions answered). The score ranges from 0 to 100. Based on the patient's score, it is reported as normal (0-12), mild (13-22), moderate (23-32), or severe (>33) DED.

The responses were obtained in Microsoft Excel and the OSDI scores were calculated. Analysis was done using SPSS software version 23. Continuous variables were reported with their mean ± SD. Logistic regression was done to assess various risk factors for OSDI. A P-value of <0.05 was considered significant.

RESULTS

The mean age of the participants was 33.3 ± 9.7 years. The sex ratio (male: female) was 1:1.9. The demographic characteristics of the participants are depicted in table 1. The median OSDI was 6.25 (R 0 to 66.7). Based on OSDI, 30.6% (n=64) participants had DED with 14.8% (n=31) having mild DED, 9.1% (n=19) having moderate DED and 6.7% (n=14) having severe DED. Nearly one-third of the participants (31.6%, n=66) noticed air leak from the mask while exhalation. Although only 16 participants applied plaster over the mask/nose, the majority

Table 1: Demographic characteristics of the participants.

	N= 209
Age (Mean± SD)(in years)	33.3 ± 9.7
Sex Ratio (male: female)	1: 1.9
Specialty of practice 1. General Medicine 2. Ophthalmology 3. Obstetrics & Gynaecology 4. Surgery 5. Anesthesia 6. Orthopaedics 7. Non-clinical 8. Pediatrics 9. Dermatology	 106 (50.71%) 35 (16.7%) 21 (10%) 10 (4.8%) 9 (4.3%) 9 (4.3%) 9 (4.3%) 7 (3.3%) 3 (1.3%)
Use of computer during work	88 (42.1%)
Duration of increase in screen time during the pandemic: • Nil • < 2 hours • 2-4 hours • 4-6 hours • > 6 hours	 53 (25.4%) 20 (9.6%) 65 (31.1%) 51 (24.4%) 20 (9.6%)

(Contd...)

Table 1: *(Continued)*

Reason for the increase in screen time during the pandemic: • Entertainment • Making entry of patient details • Studying/ research work • Online class/ webinar	 121 (57.9%) 32 (15.3%) 105 (50.2%) 55 (26.7%)
Type of mask mostly used: • N95 mask • Three-ply mask	 181 (86.6%) 28 (13.4%)
Duration of wearing a mask: • < 4 hours • 4-6 hours • > 6 hours	 17 (8.1%) 63 (30.1%) 129 (61.7%)
Do you use plaster over the mask and nose? • No • Yes	 193 (92.3%) 16 (7.7%)
Presence of air leak from mask to eyes? • No • Yes	 143 (68.4%) 66 (31.6%)
Participants using contact lens	22 (10.5%)
History of DED before COVID pandemic	30 (14.4%)

(87%,n=14) of them didn't have air leak while exhalation. Univariate and multivariate logistic regression analysis showed the presence of air leak from mask to eyes during exhalation increased the odds of having DED by 2.2 times and history of DED (before COVID-19 pandemic) also increased the odds of having DED by 2.3 times (table 2).

DISCUSSION

The COVID-19 pandemic has increased the prevalence of symptoms of dry eye and ocular irritation with prevalence varying from 7.9 % to as high as 84.3% (table 3).[22,24,28–45] In our study prevalence of DED was 30.6%. The

Table 2: Univariate and multivariate logistic regression analysis for various risk factors associated with DED (based on OSDI score) during COVID-19 pandemic

Parameters	**Unadjusted odds ratio**		**Adjusted odds ratio**	
	OR value	**P value**	**OR value**	**P value**
Age	0.98 (0.95-1.01)	0.3	NA	
Sex	1(0.5 -1.8)	0.91	NA	
Increase in screen time <2 hours 2-4 hours 4-6 hours > 6 hours	 0.7 (0.2-2.7) 1.4 (0.6-3) 1.7 (0.7-3.9) 2.5 (0.8-7.4)	 0.61 0.52 0.23 0.09	 0.7 (0.2-2.6) 1.4 (0.6-3.3) 2 (0.8-5) 2 (0.6-6.5)	 0.6 0.46 0.13 0.2
Wearing N95 mask	0.9 (0.4-2.1)	0.85	NA	
Application of plaster over mask	1.4 (0.48-4)	0.53	NA	
Presence of air leak from mask to eye	1.9 (1-3.6)	**0.03**	2.2 (1-5.5)	**0.02**
Duration of wearing the mask < 4 hours 4-6 hours > 6 hours	 Constant 1 (0.3-3.3) 1.1 (0.3-3.3)	 0.95 0.84	NA	
History of DED before COVID pandemic	2.6 (1.2-5.8)	**0.01**	2.3 (1.2-5.7)	**0.04**

Table 3: Studies about dry eye disease in healthcare workers or medical students during the COVID-19 pandemic.

Study, year, country	No. of participants/ study population	Age (Mean)	Method used to assess dry eye	Prevalence	Risk factors
Giannaccare G et al[24] 2020, Italy	107, Resident doctors	28.5 years	OSDI	57%	VDT use, Face mask wear
Long Y et al[29] 2020, China	53, Medical staffs	32.4 years	OSDI	35.84%	Older age
Marinova E et al45 2020, Bulgaria	144, Medical personnel and patients	43 years (median age)	Slit lamp biomicroscopy, Ocular surface Fluorescein staining evaluation, Schirmer's test, TBUT	70.1%	Type of mask used, Duration of mask usage
Boccardo L et al22 2021, Italy	3605, Mixed population	31 years (median age)	Self-reported MADE	18.3%	Female sex, Use of correction (glasses and Contact lens), Retailers by occupation
Yousef H et al, 2021, Egypt	80, Medical students	21.2 years	OSDI	75 %	Prolonged VDT exposure, Mask usage
Fan Q et al 2022, China	6925, Mixed population	14 years (median age)	MADE Q	7.90%	Increased age, Female sex, Use of glasses and Contact lens, Frequent wear of face masks, Longer daily mask-wearing time, Non-standard wearing of face masks, Dry environment, Reduced daily reading time, less outdoor time, shorter VDTs, Higher education level
Azzam S et al ,2022,Israel	Group 1-30 Group 2-30 Healthcare workers	Group 1-35.3 years Group 2-36.6 years	OSDI, TBUT, corneal and conjunctival fluorescein staining, and meibography	Group1-46.7% Group2-53.3%	N95 mask caused significantly more dryness than the Surgical mask
Baris M et al, 2022, Turkey	33, Healthcare professionals	33.6 years	OSDI,TBUT	57.6%	Prolonged mask wear
Dag U et al, 2022, Turkey	333, Healthcare professionals		Self-reported MADE based on web-based 12 questions Questionnaire	70%	Prolonged mask wear
Tangmonkong-voragul C et al, 2022, Thailand	528 Medical students	20.48 years	OSDI, Lipi View II Interferometry, Meibograde	70.8%	Female gender, prolonged hours of contact lens wear, higher frequency use of artificial tears per day, prolonged duration of VDT use, psychological stress
Al-Dolat W et al, 2022, Jordan	1219 Medical students	18-24 years	OSDI	71.7%	Female sex, basic science years, allergy reporting, spending more than 6 h looking at screens
Erogul et al, 2022, Turkey	392 Healthcare professionals	18-55 years	Thirty question Google survey questionnaire		Prolonged PFM wear

(Contd...)

Table 3: *(Continued)*

Study, year, country	No. of participants/ study population	Age (Mean)	Method used to assess dry eye	Prevalence	Risk factors
Alghamdi N et al, 2022, Saudi Arabia	415 Healthcare workers	18-60 years	SPEED Questionnaire	70.9%	Age, occupation, duration of mask-wearing, time spent on digital screens
Tripathi A et al 2022, India	80 Medical students	20 years	OSDI ,Schirmer's Test	Symptomatic dry eye-41% Dry eye based on signs -25%	Increased hours spent on different digital devices
Allayed R et al 2022, Palestine	300 Nurses	<35 Years and >35 years	OSDI Questionnaire	62%	Demographic characteristics of the nurses and work conditions such as age, smoking, contact lenses, work department, and work-time shift
Ezinne N et al, 2023, Tobago and Trinidad	400 Medical students and students of other disciplines	18-35 years	OSDI Questionnaire	84.3%	An average of >5 hours of VDU use per day, refractive error, history of systemic medication, education about dry eye
Celik E et al, 2023, Turkey	Long-term group -64 Short term group-66 Healthcare professionals	Long term group-36.3 years Short-term group -35.9 years	OSDI, TBUT, Schirmer's Test 1, Oxford staining score, meibography, Lid parallel conjunctival fold		Prolonged mask wear
Lulla N et al, 2023, India	271 Medical students	-	Modified OSDI Questionnaire	41.5 %-Pre pandemic 55.19% -pandemic	Increased screen time, History of treatment for DED in the past, partial vaccination with COVID vaccine

reason for the huge variation in prevalence could be due to the differences in the method used to assess the DED, different age groups & sex of the population assessed, etc. Various contributing risk factors postulated were older age, female sex, use of corrections (glasses and contact lens), higher use of visual display terminals, reduced blink rate, incomplete blinking, extensive and frequent use of face mask, type and duration of mask usage, pre-existing DED, dry environment, higher education level, awareness about dry eye disease, allergic disease, keratoconus, increased frequency of instillation of artificial tears, psychological stress, smoking, etc.[22,24,25,28,29,45]

Our study suggests that the presence of air leak from the mask to the eyes during exhalation increased the odds of having DED by 2.2 times. Many other studies also showed an increase in dry eye due to leak of air from face mask.[24,33,45,46] The use of face masks significantly reduces the outward spread of air. However, exhaled air still needs to disperse. The outflow of exhaled air, with a temperature around 36-37°C, passes over the upper border of the face mask to the ocular surface. This direct hot airflow leads to instability, increased evaporation, hyperosmolarity, and a decline in tear film turnover and clearance and results in ocular damage and dry eye symptoms. Besides, the exhaled air has a decreased level of oxygen and an increased carbon dioxide concentration, which decreases the tear pH levels and consequently impairs the ocular surface. The increased carbon dioxide concentration reduces the stromal pH, which excites the corneal nociceptors and thus evokes corneal pain sensations. Ocular hypoxia results in excessive production of reactive oxygen species that promote inflammation and neovascularization by the activation and apoptosis of leucocytes, and expression of pro-inflammatory factors, including vascular endothelial growth factor and interleukins by endothelial and epithelial cells.[45] The displacement of the mask or its incorrect fitting could increase this dispersion of air around the eyes and the air leak. A tight contact mask especially with nose wire fitting prevents the airflow over the top of the mask. However, in that case, the normal position of the palpebrae could be

harmed leading to incomplete blinking, lagophthalmos, and exposure keratopathy.[33,45] Air convection also contributes to dry environments.[46] The environment plays a major role in tear film instability.[44] Contrary to our study, wearing a facemask was not significantly associated with symptomatic DED in a study by Al-Dolat et al.[37]

A population-based study conducted in China in 2021 suggested an increased incidence of MADE due to the use of masks, found significant association between perceived MADE and pre-existing dry eye. Also a higher incidence of MADE was related to the nonstandard wearing of mask.[28] Poorly fitting facemasks reverse the normal direction of nasal (and mouth) breathing. Rather than diverting inspiration and expiration airflow away from the eyes, such facemasks inadvertently expose the vulnerable ocular surface to mechanical desiccation and nasopharyngeal pathogens. Preventative measures such as applying surgical tape to the top of the facemask seal the upper mask edge onto the nose and midface and so restrict any redirected exhaled airflow.[47] Also it has been postulated that the tape adhering to the skin of the upper cheek may interfere with the normal excursion of the lower eyelid, possibly inducing mechanical ectropion with secondary lagophthalmos.[48] Likewise, the tight contact in N95 respirators prevents the airflow over the top of the mask, in that case, the normal position of the palpebrae could be harmed leading to incomplete blinking and exposure keratopathy.[45] Contrary to this, a study by Nair et al showed taping of the upper mask edge gave significantly better ocular surface stability, which correlated well with a decrease in dry eye symptoms.[49] A study by Tagawa et al. demonstrated corneal hyperalgesia in DED patients with short tear film breakup time.[50] The fact that the patients with dry eye might have higher sensitivity for noticing these symptoms could explain the difference between the groups(healthy subjects vs subjects with h/o DED).[25]

Our study showed that the history of DED (before the COVID-19 pandemic) increased the odds of having DED by 2.3 times. In a study by Krolo et al, subjects with prior DED reported worsening of their symptoms during the mask-wearing period regardless of mask-wearing duration.[25] Fan et al found significant associations between perceived MADE and pre-existing dry eye.[28] Alghamdi et al found that eye soreness or irritation, eye dryness, grittiness or scratchiness were generally more frequent and worse as the duration of facemask wearing increased among participants with pre-existing dry eye problems.[39] Lulla et al, in their study, found that students who had previously received treatment for DED experienced worsening of symptoms during the pandemic due to disease exacerbation.[44]

In our study, the odds of developing dry eye increased with an increase in screen time, but it was not statistically significant. However, a survey by Giannaccare et al found a significant association between DED and intense visual terminal display use.[24] The excessive evaporation of tear fluid attributable to prolonged blinking intervals while gazing is thought to be the main causative factor.

Our study did not show any significant association between the duration of face mask use and DED. However, Marinova et al found a positive correlation between the time of mask usage and the presence and severity of the complaints.[45] According to their study healthcare personnel had the highest prevalence of ocular complaints with the most severe clinical picture related to the necessity of prolonged usage of protective equipment.

Limitations: As we conducted an online survey using OSDI questionnaire, DED was not clinically confirmed. It would been have better if the change in symptoms of DED was assessed after taping the mask to the nose.

CONCLUSION

There is a higher rate of prevalence of DED among doctors during the COVID-19 pandemic. The presence of air leak from mask is an important modifiable risk factor. Doctors especially those with a previous history of DED should take adequate precautions to prevent DED during any upcoming pandemic like COVID-19 as they have increased odds of developing DED.

FINANCIAL SUPPORT AND SPONSORSHIP

Nil.

CONFLICTS OF INTEREST

There are no conflicts of interest.

REFERENCES

1. Spiteri G, Fielding J, Diercke M, Campese C, Enouf V, Gaymard A, et al. First cases of coronavirus disease 2019 (COVID-19) in the WHO European Region, 24 January to 21 February 2020. Euro Surveill 2020;25(9):2000178.
2. Bedford J, Enria D, Giesecke J, Heymann DL, Ihekweazu C, Kobinger G, et al. COVID-19: towards controlling of a pandemic. The Lancet 2020;395(10229):1015–8.

3. Keni R, Alexander A, Nayak PG, Mudgal J, Nandakumar K. COVID-19: Emergence, Spread, Possible Treatments, and Global Burden. Front Public Health 2020;8:216.
4. Jayaweera M, Perera H, Gunawardana B, Manatunge J. Transmission of COVID-19 virus by droplets and aerosols: A critical review on the unresolved dichotomy. Environ Res 2020;188:109819.
5. Khanna RC, Honavar SG. All eyes on Coronavirus-What do we need to know as ophthalmologists. Indian J Ophthalmol 2020;68(4):549–53.
6. Hoernke K, Djellouli N, Andrews L, Lewis-Jackson S, Manby L, Martin S, et al. Frontline healthcare workers' experiences with personal protective equipment during the COVID-19 pandemic in the UK: a rapid qualitative appraisal. BMJ Open 2021;11(1):e046199.
7. Hakim M, Khattak FA, Muhammad S, Ismail M, Ullah N, Atiq Orakzai M, et al. Access and Use Experience of Personal Protective Equipment Among Frontline Healthcare Workers in Pakistan During the COVID-19 Emergency: A Cross-Sectional Study. Health Secur 2021;19(2):140–9.
8. Mahalingam K, Surbhi null, Balaji A, Ganesh R, Daniel RA, Aggarwal R, et al. Is it a challenging task to work with personal protective equipment in a COVID-19 ICU: Findings from a hospital-based cross-sectional study from north India. J Family Med Prim Care 2022;11(5):1935–42.
9. Feng S, Shen C, Xia N, Song W, Fan M, Cowling BJ. Rational use of face masks in the COVID-19 pandemic. Lancet Respir Med 2020;8(5):434–6.
10. Howard J, Huang A, Li Z, Tufekci Z, Zdimal V, van der Westhuizen HM, et al. An evidence review of face masks against COVID-19. Proc Natl Acad Sci U S A 2021;118(4):e2014564118.
11. Esposito S, Principi N, Leung CC, Migliori GB. Universal use of face masks for success against COVID-19: evidence and implications for prevention policies. Eur Respir J 2020;55(6):2001260.
12. Fan J, Metting A. COVID-19 online medical education and outcomes on Internal Medicine In-Training Examination scores. Proc (Bayl Univ Med Cent) 36(3):360–2.
13. Mahalingam K, Saxena R. Commentary: COVID-19 pandemic and stress level of residents and fellows during ophthalmology training. Indian J Ophthalmol 2022;70(6):2174–5.
14. Mahalingam K, Sharma N, Ganesh R, Panigrahi A, Patil V, Saxena R. The impact of COVID-19 pandemic on training and mental health of ophthalmology residents and fellows in India: A survey. Indian Journal of Ophthalmology 2023;71(9):3262.
15. Craig JP, Nichols KK, Akpek EK, Caffery B, Dua HS, Joo CK, et al. TFOS DEWS II Definition and Classification Report. Ocul Surf 2017;15(3):276–83.
16. Shimazaki J. Definition and Diagnostic Criteria of Dry Eye Disease: Historical Overview and Future Directions. Invest Ophthalmol Vis Sci 2018;59(14):DES7–12.
17. Smith JA, Albenz J, Begley C, Caffery B, Nichols K, Schaumberg D, et al. The epidemiology of dry eye disease: Report of the epidemiology subcommittee of the international Dry Eye WorkShop (2007). The ocular surface 2007;5(2):93–107.
18. Wolffsohn JS, Arita R, Chalmers R, Djalilian A, Dogru M, Dumbleton K, et al. TFOS DEWS II Diagnostic Methodology report. Ocul Surf 2017;15(3):539–74.
19. Lu F, Tao A, Hu Y, Tao W, Lu P. Evaluation of Reliability and Validity of Three Common Dry Eye Questionnaires in Chinese. Journal of Ophthalmology 2018;2018:e2401213.
20. Shujaat S, Jawed M, Memon S, Talpur KI. Determination of Risk Factors and Treatment of Dry Eye Disease in Type 1 Diabetes Before Corneal Complications at Sindh Institute of Ophthalmology And Visual Sciences. Open Ophthalmol J 2017;11:355–61.
21. Yang WJ, Yang YN, Cao J, Man ZH, Yuan J, Xiao X, et al. Risk Factors for Dry Eye Syndrome: A Retrospective Case-Control Study. Optometry and Vision Science 2015;92(9):e199.
22. Boccardo L. Self-reported symptoms of mask-associated dry eye: A survey study of 3,605 people. Cont Lens Anterior Eye 2021;101408.
23. Pandey SK, Sharma V. Mask-associated dry eye disease and dry eye due to prolonged screen time: Are we heading towards a new dry eye epidemic during the COVID-19 era? Indian J Ophthalmol 2021;69(2):448–9.
24. Giannaccare G, Vaccaro S, Mancini A, Scorcia V. Dry eye in the COVID-19 era: how the measures for controlling pandemic might harm ocular surface. Graefes Arch Clin Exp Ophthalmol 2020;258(11):2567–8.
25. Krolo I, Blazeka M, Merdzo I, Vrtar I, Sabol I, Petric-Vickovic I. Mask-Associated Dry Eye During COVID-19 Pandemic–How Face Masks Contribute to Dry Eye Disease Symptoms. Med Arch 2021;75(2):144–8.

26. Koh S, Rhee MK. COVID-19 and Dry Eye. Eye Contact Lens 2021;47(6):317–22.
27. Schiffman RM, Christianson MD, Jacobsen G, Hirsch JD, Reis BL. Reliability and validity of the Ocular Surface Disease Index. Arch Ophthalmol 2000;118(5):615–21.
28. Fan Q, Liang M, Kong W, Zhang W, Wang H, Chu J, et al. Wearing face masks and possibility for dry eye during the COVID-19 pandemic. Sci Rep 2022;12(1):6214.
29. Long Y, Wang X, Tong Q, Xia J, Shen Y. Investigation of dry eye symptoms of medical staffs working in hospital during 2019 novel coronavirus outbreak. Medicine 2020;99(35):e21699.
30. García-Ayuso D, Di Pierdomenico J, Moya-Rodríguez E, Valiente-Soriano FJ, Galindo-Romero C, Sobrado-Calvo P. Assessment of dry eye symptoms among university students during the COVID-19 pandemic. Clinical and Experimental Optometry 2022;105(5):507–13.
31. Cartes C, Segovia C, Salinas-Toro D, Goya C, Alonso MJ, Lopez-Solis R, et al. Dry Eye and Visual Display Terminal-Related Symptoms among University Students during the Coronavirus Disease Pandemic. Ophthalmic Epidemiol 2022;29(3):245–51.
32. Shamselden Yousef, M.D. H. Visual Display and Dry Eye Related Symptoms among Medical Students During Corona Virus Waves. The Medical Journal of Cairo University 2021;89(12):2909–13.
33. Azzam SH, Nama A, Badarni H, Asael H, Dahoud WA, Mimouni M, et al. Assessment of dry eye disease in N95 versus surgical face mask wearers during COVID-19. Indian J Ophthalmol 2022;70(3):995–9.
34. Esen Baris M, Guven Yilmaz S, Palamar M. Impact of prolonged face mask wearing on tear break-up time and dry eye symptoms in health care professionals. Int Ophthalmol 2022;42(7):2141–4.
35. Dag U, Çaglayan M, Öncül H, Vardar S, Alaus MF. Mask-associated Dry Eye Syndrome in Healthcare Professionals as a New Complication Caused by the Prolonged Use of Masks during Covid-19 Pandemic Period. Ophthalmic Epidemiol 2023;30(1):1–6.
36. Tangmonkongvoragul C, Chokesuwattanaskul S, Khankaeo C, Punyasevee R, Nakkara L, Moolsan S, et al. Prevalence of symptomatic dry eye disease with associated risk factors among medical students at Chiang Mai University due to increased screen time and stress during COVID-19 pandemic. PLoS One 2022;17(3):e0265733.
37. Al-Dolat W, Abu-Ismail L, Khamees A, Alqudah N, Abukawan MM, Alrawashdeh HM, et al. Is wearing a face mask associated with symptomatic dry eye disease among medical students during the COVID-19 era? An online survey. BMC Ophthalmol 2022;22(1):159.
38. Erogul O, Gobeka HH, Kasikci M, Erogul LE, Balci A. Impacts of protective face masks on ocular surface symptoms among healthcare professionals during the COVID-19 pandemic. Ir J Med Sci 2023;192(2):521–6.
39. Alghamdi NM, Mandoura NA. Facemask Associated Dry Eyes among Healthcare Workers during COVID-19 Pandemic, Jeddah, Saudi Arabia. MS 2022;26(125):1–13.
40. Tripathi A, Agarwal R, Kharya P. Dry eye disease related to digital screen exposure in medical students. The Pan-American Journal of Ophthalmology 2022;4(1):35.
41. Allayed R, Ayed A, Fashafsheh I. Prevalence and Risk Factors Associated with Symptomatic Dry Eye in Nurses in Palestine During the COVID-19 Pandemic. SAGE Open Nurs 2022;8:23779608221127948.
42. Ezinne N, Alemu HW, Cheklie T, Ekemiri K, Mohammed R, James S. High Prevalence of Symptomatic Dry Eye Disease Among University Students During the COVID-19 Pandemic in University of West Indies, Trinidad and Tobago. Clin Optom (Auckl) 2023;15:37–43.
43. Celik E, Polat E, Gunder EK, Barut E, Gonen T. Mask-Associated Dry Eye (MADE) in healthcare professionals working at COVID-19 pandemic clinics. Niger J Clin Pract 2023;26(3):319–23.
44. Lulla NH, Loganathan M, Balan VGM, Swathi S. Dry eye among medical students before and during COVID-19. Indian J Ophthalmol 2023;71(4):1468–71.
45. Marinova E, Dabov D, Zdravkov Y. Ophthalmic complaints in face-mask wearing: prevalence, treatment, and prevention with a potential protective effect against SARS-CoV-2. Biotechnology & Biotechnological Equipment 2020;34(1):1323–35.
46. Alanazi MA, El-Hiti GA, Al-Tamimi R, Bawazir AM, Almutleb ES, Fagehi R, et al. Assessment of the Effect of Wearing a Surgical Face Mask on Tear Film in Normal Eye Subjects. J Ophthalmol 2022;2022:2484997.
47. Chadwick O, Lockington D. Addressing post-operative Mask-Associated Dry Eye (MADE). Eye 2021;35(6):1543–4.

48. Moshirfar M, West WB, Marx DP. Face Mask-Associated Ocular Irritation and Dryness. Ophthalmol Ther 2020;9(3):397–400.
49. Nair S, Kaur M, Sah R, Titiyal JS. Impact of Taping The Upper Mask Edge On Ocular Surface Stability and Dry Eye Symptoms. Am J Ophthalmol 2022;238:128–33.
50. Tagawa Y, Noda K, Ohguchi T, Tagawa Y, Ishida S, Kitaichi N. Corneal hyperalgesia in patients withshort tear film break-up time dry eye. Ocul Surf 2019;17(1):55–9.

How to cite this article: Chelliah R, Nidhi K, Dhatchayani H, Rangasamy R, Ramani S, Daniel R A, Mahalingam K. Assessment of risk factors for Dry eye disease among Doctors in South India during the COVID-19 pandemic: An online survey and review of literature. Ocul Res J 2024;1(2): 5-13.

Received: 14/05/2024 **Accepted:** 27/05/2024