Original Article

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Ophthalmology Section

Mask Associated Dry Eye (MADE) in Healthcare Workers: A Cross-sectional Study

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ABSTRACT

Introduction: The Coronavirus disease-19 (COVID-19) pandemic mediated by Severe Acute Respiratory Syndrome-CoV2 (SARS-CoV2), made the use of face masks mandatory to check the spread of the disease. With the increased use of face masks, more people started presenting to the ophthalmologist with symptoms of dry eye. The proposed mechanism of dry eye was attributed to air blowing upwards from behind the mask into the eyes, especially in loose fitting masks. This air leads to rapid evaporation of tears and disturbance of homeostasis of the tear film.

Aim: To measure self reported symptoms of dry eye and to establish mask use as a risk factor for the development of Dry Eye Disease (DED) in healthcare workers in a Tertiary Care Hospital.

Materials and Methods: This cross-sectional, observational study was conducted at Nilratan Sircar (NRS) Medical College and Hospital for a duration of three months from December 2021 to February 2022. The study was conducted on 146 participants. An online survey was conducted using Google Forms, sent via email to hospital employees working in different departments of the hospital. All healthcare workers employed at NRS Medical College and Hospital who wore a face mask during duty hours and were willing to participate in the study were included. The Ocular Surface Disease Index (OSDI) questionnaire was used and modified by adding "while wearing a facemask" to the end of each question. To establish face mask use as a causative agent for development of DED, a few other questions related to face mask usage were included in the survey. The data was tabulated in Microsoft Excel and analysed with Statistical Package for Social Sciences (SPSS) version 24.

Results: The mean age of the study population was 27.4±8.28 years. The mean hours of wearing a mask was 6.38 ±3.04 hours. N95 face mask was the most common type of mask used. The study population included 100 doctors, 14 nursing staff, 18 optometrists, eight group D staff (sweepers and ward attendants), and six dieticians. The mean OSDI score was 14.24. Increased usage of face masks, in particular surgical, more hours of reading significantly correlated with higher incidence of DED.

Conclusion: This study showed that increased hours of face mask use in particular surgical was associated with development of DED. To encourage more people to wear face masks, all possible problems arising from face mask use should be promptly identified and dealt with.

Keywords: Coronavirus disease-19, Dry eye disease, Ocular surface disease index

INTRODUCTION

Dry eye is a multifactorial disease of the ocular surface characterised by tear film hyperosmolarity, ocular surface inflammation and tear film instability resulting in a loss of homeostasis of the tear film [1]. DED spectrum can range from minor discomfort to rarely sight-threatening complications. Discomfort is seen more in pre-existing DED, while more visual symptoms are seen in new-onset DED [2]. The prevalence of DED in various american and australian studies ranges from 5%-16%, whereas Asian studies show a higher prevalence of approximately 27%-33% [3-6].

The ongoing COVID-19 pandemic has compelled everyone to use face masks to prevent further spread of the disease. In June 2020, DE White, an American ophthalmologist, mentioned in his blog about the increasing number of DED patients in his clinic and called it Mask associated Dry Eye (MADE) [2]. The possible aetiology is the increased evaporation of the tear film as the exhaled air is forced up and out of the top of the mask, especially if the mask is not snugly fit against the face. This evaporation over a period of time, results in a thinner and less stable tear film. Punctate ocular surface staining may be seen clinically. People who wear masks for prolonged periods reports irritated, uncomfortable, red, dry-feeling eyes [7]. Irritation of the eye via similar mechanisms has been described. Continuous Positive Airway Pressure (CPAP) therapy increased tear evaporation and thus ocular irritation in patients with sleep apnoea [8]. The first study to describe the prevalence of MADE analysed a total of 3,605 responses in an online survey. A total of 2,447 people reported having symptoms, of which 658 (26.9%) participants reported their symptoms exaggerated while wearing a mask. An 18.3% of all participants experienced MADE [9]. A prospective cohort study also identified MADE and the risk factors associated with it. Female gender subjects with a history of prior DED, and wearing a face mask longer than three hours per day were the main associated factors [10].

This study aims to find the association between facemask use and development of DED in healthcare workers of a Tertiary Care Hospital, since this subgroup uses facemask for longer hours.

MATERIALS AND METHODS

This cross-sectional, observational study was conducted at NRS Medical College and Hospital, from December 2021 to February 2022. An anonymous online survey was distributed using Google Forms to hospital employees working in different departments. The Institution Ethics Committee of our centre approved the study. (Letter No-NRSMC/IEC/201/2022).

Sample size calculation: was done in G*Power 3.1.9.2 software and considering 5% alpha error with 80% power of the study, the sample size was calculated as 140.146 samples were included in the study.

Inclusion criteria: All healthcare workers employed at NRS Medical College and Hospital who wore face masks during duty hours and were willing to participate in the study were included.

Exclusion criteria: History of ocular surgery or trauma, any Vitamin A deficiency, nasolacrimal duct obstruction, lid retraction and 7th cranial nerve palsy.

Study Procedure

A patient consent form was present at the beginning of each questionnaire. The online survey consisted of clinico-demographic factors, department where the person was currently working, and designation of the person. The OSDI Questionnaire [11] was used with some modifications. The questionnaire included 12 questions, consisting of three groups-ocular symptoms, vision-related functions and environmental triggers [Table/Fig-1]. The responses are graded on a scale from 0 to 4: 0-none of the time:

- Some of the time;
- Half of the time;
- Most of the time;
- All of the time.

Items
Ocular symptoms
1 Eyes that are sensitive to light?
2 Eyes that feel gritty?
3 Painful or sore eyes?
4 Blurred vision?
5 Poor vision?
Vision-related functions
6 Problems with reading?
7 Problems with driving at night?
8 Problems with working with a computer or bank machine (automated teller machine)?
9 Problems with watching television?
Environmental triggers
10 Problems in windy conditions?
11 Problems in places or areas with low humidity (very dry)?
12 Areas that are air-conditioned?

[Table/Fig-1]: Shows the items of the Ocular Surface Disease Index (OSDI) questionnaire.

The total score was calculated on the basis of the following formula: OSDI={(sum of scores for all questions answered)×100}/{(total number of questions answered)×4}. Original OSDI questionnaire was modified by adding "while wearing a facemask" at the end of each question (e.g., Have you experienced eyes that are sensitive to light during the last week while wearing a facemask). The OSDI questionnaire has high internal consistency and an excellent validity. In a large sample of patients with DED and normal controls, good to excellent test-retest reliability was seen [12]. In the OSDI questionnaire, the following questions were included as they can be potential risk factors for the development of DED [9,10,13-17]:

Average hours of face mask use

- Type of mask most commonly used
    - History of DED. If there was a previous history of DED, the severity was graded based on the original OSDI questionnaire. The patients had to answer the questionnaire based on their symptoms prior to the use of face masks. A score of 0-12 was taken as normal, 13-22 was considered as Mild disease, 23-32 as moderate disease and 33-100 as severe disease [18].
    - Awareness of air blowing upward during mask use;
    - Any history of contact lens use and duration of such use;
    - Average hours of use of electronic devices like computer, mobile phones, TV, etc.,
    - Average hours of reading;
    - Whether the subject has reached menopause;
    - Use of Oral Contraceptive Pills (OCPs);
    - Use of eye drops like anti-glaucoma drugs, lubricants, etc.,

STATISTICAL ANALYSIS

The Pearson's Correlation Coefficient was calculated to find out the correlation between hours of mask use and the OSDI score and also found out the type of face mask use that is most likely to cause DED. The data was tabulated in Microsoft Excel and analysed with SPSS V.24 software. Pearson's correlation, independent t-test and one-way Analysis of Variance (ANOVA) were used in the statistical analysis. The p-value ≤0.05 was considered as statistically significant.

RESULTS

The study included 146 participants, with a mean age of 27.4±8.28 years, among which 78.08% (114) were women. There were 100 doctors, 14 nursing staff, 18 optometrists, 8 group D staff (sweepers and ward attendants), and 6 dieticians. Hundred doctors, 14 nursing staff, 18 optometrists, 8 group D staff (sweepers and ward attendants), and 6 dieticians. 41.78% (N=61) of people reported having symptoms of dry eye during mask use. A 46% had mild disease, while 37.7% and 16.4% had moderate and severe disease, respectively. [Table/Fig-2,3] shows the demographic data obtained from the study.

Department	N (%)
Anaesthesia	2 (1.37%)
Community medicine	4 (2.74%)
Dermatology	8 (5.48%)
Emergency medicine	2 (1.37%)
ENT	6 (4.11%)
Ophthalmology	22 (15.07%)
Obstetrics and gynaecology	4 (2.74%)
ICU	2 (1.37%)
Medicine	14 (9.59 %)
Paediatrics	6 (4.11%)
Psychiatry	16 (10.96%)
Radiodiagnosis	4 (2.74%)
Radiotherapy	4 (2.74%)
Surgery	6 (4.11%)

[Table/Fig-2]: Shows percentage of doctors in different departments. N=100. ENT: Ear nose throat; ICU: Intensive care unit

Parameters	Mean±SD
Age	27.4±8.28 years
Average hours of face mask use	6.38±3.04 h
Average hours of electronic device use like computer, mobile phones, TV, etc.,	4.78±2.56 h
Average hours of reading	3.93±2.50 h
Parameters	**N (%)**
Surgical facemask use	56 (38.36%)
Cloth facemask use	16 (10.96%)
N95 facemask use	74 (50.68%)
No previous history of DED	104 (71.23%)
Previous history of mild DED	22 (15.06%)
Previous History of moderate DED	14 (9.58%)
Previous history of severe DED	6 (4.10%)
No awareness of air blowing upward during mask use	23 (15.75%)
Awareness of air blowing upward during mask use	123 (84.24%)
Contact lens use	6 (4.10%)
Women who have reached menopause	12 (10.52%)
Women on oral contraceptive pills	4 (3.50%)
Patients on anti-glaucoma drops	3 (2.05%)
Patients on lubricating eye drops	15 (10.27%)

[Table/Fig-3]: Shows mean and SD of age, average hours of mask use, average hours of ED use, average hours of reading, type of mask most commonly used, any previous history of DED, awareness of air blowing upward during mask use, people using contact lens, women who have reached menopause and women on Oral Contraceptive Pills.
ED: Electronic device; DED: Dry eye disease

The mean OSDI score for the whole study population was 33.13±12.79. [Table/Fig-4] shows Mean OSDI score according to people working in different departments, gender, hours of mask usage, people having awareness of air blowing upward during mask use and previous history of DED. The highest mean OSDI score was recorded for subjects who were working in the Paediatric Medicine Department which was 28.20 and the lowest mean OSDI score was noted in the ENT Department which was 4.41.The average duration of contact lens use was 4±0.02 hours.

Department	Mean OSDI score	SD	p-value
Anaesthesia	18.75	0.00	0.005*
Community medicine	19.79	10.83	
Dermatology	20.83	7.86	
Dietician	5.52	7.01	
Emergency medicine	4.34	0.00	
ENT	14.58	8.12	
Ophthalmology	10.63	11.69	
Obstetrics and gynaecology	18.00	5.77	
ICU	6.25	0.00	
Medicine	13.69	17.71	
Paediatrics	23.61	16.27	
Psychiatry	18.48	12.87	
Radio diagnosis	30.20	22.85	
Radio therapy	29.20	21.69	
Surgery	13.00	0.00	
Gender			
Male	11.64	11.52	0.053
Female	15.86	13.33	
Type of mask			
Surgical mask	13.16	12.04	0.097
Cloth mask	9.11	6.08	
N95 mask	16.17	14.06	
History of DED			
Yes	14.26	16.36	0.958
No	14.08	12.36	
Awareness of air blowing upward during mask use			
Yes	15.53	13.27	0.006
No	7.68	7.11	
Contact lens use			
Yes	13.42	11.62	0.026
No	10.56	5.86	
Whether subject has reached menopause			
Yes	11.46	10.42	0.356
No	14.86	12.32	
Oral contraceptive pill use			
Yes	13.26	12.21	0.888
No	14.42	16.31	
Use of antiglaucoma drops			
Yes	15.53	12.26	0.671
No	10.42	13.21	

[Table/Fig-4]: Mean OSDI Score, SD and p-value for people working in different Departments, for gender, type of mask use, history of DED and awareness of air blowing upwards during mask use.
OSDI: Ocular surface disease index.
*Statistically significant (p<0.05)

[Table/Fig-5] depicts the Pearson's Correlation Coefficient and p-value calculated to find out the correlation of age, hours of face mask use, hours of electronic device use and hours of reading with the OSDI score.

Correlation between	Pearson's correlation coefficient(r)	p-value	Interpretation
Age and OSDI score	-0.121	0.146	Negative correlation
Mask hours and OSDI score	0.190	0.022*	Positive correlation
Surgical mask hours and OSDI score	0.518	<0.001*	Positive correlation
Cloth mask hours and OSDI score	0.254	0.342	Positive correlation
N95 mask hours and OSDI score	-0.116	0.324	Negative correlation
Hours of ED use and OSDI score	0.023	0.785	Positive correlation
Hours of reading and OSDI score	0.207	0.012*	Positive correlation

[Table/Fig-5]: Pearson's Correlation of age, mask hours, hours of ED use and hours of reading with OSDI score.
ED: Electronic device; OSDI: Ocular surface disease index
*Statistically significant (p<0.05)

DISCUSSION

This study was done to evaluate the relationship between face mask use and MADE prevalence. In this study, 41.78% of people reported having symptoms of dry eye during mask use. In a survey of 3,605 people on mask associated dry eye, the prevalence of MADE was 18.3% [9]. However, in a study by Dag U et al., 70% prevalence of self-reported Mask associated dry eye was seen among healthcare workers. The prolonged use of face masks associated with longer working hours in healthcare workers may be responsible for the higher prevalence of MADE in this population [19].

In this study, women had a higher mean OSDI score (15.86) compared to men (11.64). This result was consistent with previous findings of higher prevalence of DED in women compared to men [20]. Increasing age was not positively correlated with the OSDI score in this sample. This finding is similar to a study which investigated the self-reported symptoms of mask associated dry eye in a sample of 3605 people [9]. This observation could be justified by the fact that older people wear masks for fewer hours than workers. Moreover, in comparison to dry eye MADE is a temporary condition due to a local environmental change. Temperature and humidity of the air inside the mask is higher than that of ambient air. More hours of face mask use was found to be associated with a higher OSDI score suggesting that face mask use is a significant risk factor for the development of DED. Giannaccare G et al., in their study discussed how the use of face masks could contribute to the onset or increase in DED symptoms. An incorrectly fitted mask or displacement of the mask could cause air to leak around the eyes and cause a rapid evaporation of tears [21]. CPAP users report similar effects but to a lesser extent [22].

In this study, cloth and surgical mask hours use was positively correlated with the OSDI score while N95 mask hours use was negatively correlated. This may be attributed to the fact that cloth or surgical masks are loose fitting and hence a steady inflow and outflow of air occurs around the eyes from different areas around the mask edges. This exhaled air is further trapped if spectacles are worn. This is further supported by the fact that subjects who had an awareness of air blowing upward during mask use had a significantly greater mean OSDI score compared with subjects who had no awareness of air blowing upward during mask use. N95 masks are better fitted to the face with reduced gaps between the mask and skin and hence, a negative correlation was found between N95 mask hours use and OSDI score [23].

In this study, increased use of electronic devices and increased hours of reading was positively correlated with a higher OSDI score. The findings correlate with previous studies stating higher OSDI score in electronic device users with 7-8 hours of computer use daily [24,25]. Reduction of blink frequency and incomplete blinking during electronic device use contribute to accelerated tear

evaporation, leading to tear film instability and dry eye symptoms [26,27]. Out of 146 participants, 42 (28%) had prior DED symptoms. This study revealed that mean OSDI score was significantly higher in subjects with previous DED symptoms confirming similar findings that had been reported by Krolo I et al., [10]. The mean OSDI score was lower in subjects with usage of OCPs and subjects who had reached menopause, although the association was not statistically significant. In a study by Sharma A et al., subjects on OCPs showed decreased Schirmer's test values, as compared to control group. The tear film stability was also significantly reduced in women taking oral contraceptives [28]. Tear production and function is also effected by the level of circulating androgen. Perimenopausal women are more likely to develop DED and hormonal influences play a role as indicated by various studies [29].

The mean OSDI score was higher in subjects applying anti-glaucoma drops. This correlates with existing study that state that anti glaucoma drops leads to adverse changes in tear film stability and tear osmolarity [17]. Whether face mask use was solely responsible for worsening of symptoms of DED need to be elucidated.

Limitation(s)

Limitations of the study include subjective nature of OSDI score, lack of clinical confirmation of DED, incomplete data on ophthalmic history, medical history and systemic disease. Future studies with larger population are needed to confirm and explain the findings.

CONCLUSION(S)

This study provided novel data regarding MADE incidence in healthcare professionals. It established face mask use, especially surgical and cloth mask use as a risk factor for the development of dry eye. N95 mask wear was associated with lesser incidence of DED compared to surgical and cloth mask. Hence, the optimum fitting of face mask in healthcare settings is essential to avoid air from escaping upwards and the development of dry eye. Other risk factors for MADE included female gender, pre-existing DED, electronic device use and prolonged reading hours. Healthcare professionals should limit the use of electronic devices during the pandemic. Frequent blinking during reading and electronic device usage and putting lubricating drops is also warranted.

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