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Dry eye in mask wearers among healthcare workers during COVID-19 pandemic

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ABSTRACT

Purpose: To estimate the proportion of dry eye among healthcare workers (HCWs) wearing masks and to find association of dry eye disease symptoms (DEDS), Tear film break up time (TBUT) and Schirmer's test (ST) with sociodemographic factors, duration of mask wear, ill-fitting mask, and type of mask.
Materials and Methods: This is a cross-sectional study conducted in tertiary care hospital among 384 HCW's wearing mask. We took a detailed history, and did ocular examination, TBUT and ST.
Results: Of the 384 HCW's, TBUT was found to be reduced in 89 (23.2%) participants. All DEDS had a significant association with TBUT (p value for burning =0.001; p value for irritation =0.003; p value for dryness < 0.001). Among the HCWs female gender, occupation of doctors and nurses had a significant association with DEDS. One hundred and fifty (39.1%) were using combined masks. N95 was used mostly by doctors 75(81.5%). Burning sensation in the eyes was common in those wearing combined and N95 mask. Two seventy-one (70.5%) participants used masks for 8 or more hours per day and had a significant burning sensation (P=0.026). one hundred and twenty-two (68.3%) participants who were using masks for more than 12 months showed a significant dryness (P=0.00). TBUT and DEDS had a significant association with awareness of airflow.
Conclusion: We found 23.2% HCWs had dry eye. They are at a higher risk of developing mask associated with dry eye. Mask associated dry eye was more common in females, doctors, and nurses and with ill-fitting mask.

1. Introduction

Dry eye is a multifactorial disease of the ocular surface. Dry eye produces discomfort and reduced vision due to chronically unstable tear film which repeatedly breaks up into dry spots between blinks, exposing the corneal and conjunctival epithelium to evaporation. The prevalence of Dry eye disease (DED) among the normal population is found to be from 15 to 19% based on various diagnostic tests.[1–3] Prevalence of dry eye among the healthcare workers (HCWs) has not been studied before COVID pandemic.

After COVID-19 was declared a pandemic in March 2020, government health authorities have put forth a list of precautions to prevent infection transmission.[4] In the face of this unprecedented pandemic, social measures and various personal protective precautions have gained importance. One of these precautions is the prolonged use of protective face masks as part of the daily routine.[5] As the disease transmission is by the airborne route, wearing masks was made compulsory due to the concern for reducing disease transmission.[6] There is a worldwide increase in the use of face masks. An increase in ocular irritation and dryness

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among regular mask users is observed, which could be due to displacement of the mask or its incorrect fitting leading to air leak upwards on the ocular surface that could accelerate the evaporation of the tear film. Hence, prolonged continuous use of mask for hours or days may result in ocular surface irritation or inflammation.[7,8] Similar mask associated ocular surface problems have been discussed in patients receiving continuous positive airway pressure therapy.[9] The evaporation of the tear film leads to the depletion of this essential barrier against pathogenic invasion. The discomfort from dry eyes may also increase eye rubbing and face-touching behaviors with attendant fomite transmission. All these factors together have created an increased concern for ocular infections secondary to prolonged mask wear.[10,11] The mask use will still last for months or even years, and the prevalence of dry eye will increase significantly in the coming years.Most studies have assessed dry eye disease symptoms (DEDS) in mask wearers and objective assessment of dry eye with Tear film break up time (TBUT) and Schirmer's test (ST) among HCWs has not been addressed. As HCWs wear the mask for prolonged hours, they are at higher risk of developing dry eye disease especially with ill-fitting masks. Hence, we did this study to determine the proportion of dry eye among HCWs and to find the association of DEDS, and clinical signs (TBUT, ST) with sociodemographic factors, duration of mask wear, ill-fitting mask, and type of mask.

2. Materials and Methods

This cross-sectional observational study was conducted at a tertiary care hospital in India. This study was performed after obtaining approval from the Institutional Ethics committee. Written and informed consent was taken from all participants. All HCWs in our hospital were sent a circular for eye check-up for dry eye with a participant information sheet attached. Those who were willing were given a convenient time for examination in the eye outpatient department. After getting informed written consent, demographic details, and a history of symptoms of the dry eye, type of mask worn, and duration of wearing mask was obtained. When participants were using different types of masks, we documented it as combined mask. They were also enquired about any awareness of upward airflow from the mask. This was followed by a detailed ocular examination related to dry eye which included ST-1, TBUT and Tear film height. Slit lamp examination was done under fluorescein stain with cobalt blue filter to rule out punctate keratopathy, corneal erosions, and keratitis. The reading of ST less than 10 mm in 5 minutes was considered as abnormal. TBUT test is the standard clinical test, and its high sensitivity suggests a strong connection to the dry eye. It has better diagnostic value compared to ST in detecting tear film abnormality in patients.[11,12] Hence, we took TBUT as the indicator of dry eye in our participants. The cornea was stained with fluorescein dye and TBUT was noted. TBUT of less than 10 seconds was considered abnormal. A total of 384 participants were required for this study by assuming 50% of the mask wearers will have dry eye, precision 5% and confidence level of 95%.

We considered the awareness of airflow to be present when the patient could appreciate the upwards flow of air from the mask towards the eye. Those participants who have the awareness of upward airflow towards the eye were taken to have Ill-fitting masks.

2.1. Statistical analysis

The data collected were entered in a Microsoft Excel sheet and analysed using Statistical Package for Social (SPSS) software. Simple descriptive analysis was done. Categorical data were expressed in terms of percentage. Continuous data were expressed as mean ± Standard deviation. Chi-square test/Fisher's exact test was used to assess the association of categorical variables. A p-value of less than 0.05 was considered statistically significant.

3. Results

Overall 384 HCW participated in our study. Three hundred and three (78.9%) were between 21 to 30 years (Figure 1). The male to female ratio was 2.15. Amongst the participants we had 157 (40.9%) doctors, 141 (36.7%) staff nurses, 86 (22.4%) other staff (attenders, lab technicians, secretaries). TBUT was measured for all participants and was found to be abnormal in 89 (23.2%; 95% CI 0.19 – 0.28) participants. ST was found abnormal in 12 (3.1%; 95% CI 0.02 – 0.05) participants. One hundred and forty-five participants (37.8%) complained of burning sensation, 105 (27.3%) complained of dryness, 93 (24.2%) complained of irritation, and 44 (11.5%) complained of watering. All DEDS had a significant association with TBUT. No significant association of TBUT was found with gender, occupation, type of mask, duration of mask worn and airflow awareness (Table 1). Dryness ($p<0.001$) and burning ($p < 0.001$) were significantly associated with ST (Table 2). The females had significantly more DEDS than males. Doctors and nurses had significantly more DEDS. Eye burning was significantly associated with the type of mask. DEDS (except dryness) had a significant association with awareness of airflow. One twenty-two (31.8%) participants were using mask for more than 12 months and complained of significant dryness ($P < 0.001$). Two hundred and seventy-one (70.6%) participants used mask for 8 or more hours per day and had significant eye burning ($P=0.026$) (Table 3).

Age was not associated with DEDS, TBUT, ST and awareness. Most of the participants 150 (39.1%) were using different types of masks on different times (combined mask). N95 was used mostly by doctors 75(81.5%)

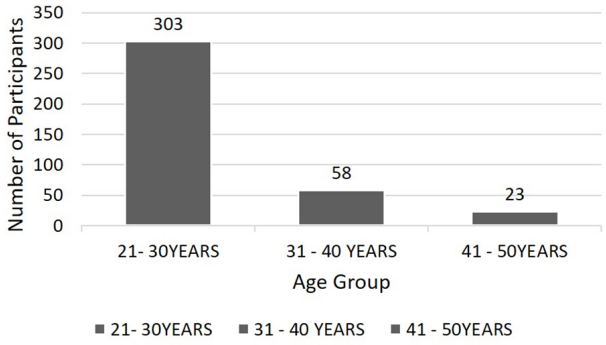

Figure 1: Age distribution of participants

(Figure 2) Those wearing N95 masks wore their masks for a significantly longer duration (≥8 hours per day) than those wearing surgical mask [77(83.7%) Vs 83(59.3%; P<0.05]. (Table 4)

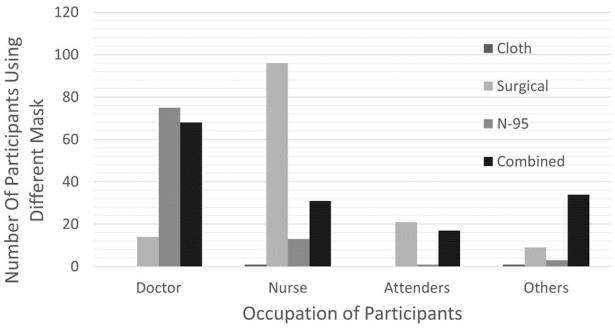

Figure 2: Use of mask type according to the designation

There was no significant association between TBUT and ST with smoking, exposure to air conditioner, using mobile or laptop or television, contact lens use, and disease such as thyroid or diabetes.

4. Discussion

The proportion of dry eye disease among mask wearers in the present study was 23.2% based on TBUT. This is higher than prevalence of dry eye among normal population which varies between 15-18%.[1–3] In the present study all DEDS had a significant association with TBUT. Female gender, doctors and nurses had significant DEDS compared to other HCWs. Eye burning was significantly associated with the combined type of mask use. Participants using masks for prolonged periods had significant eye burning and dryness. TBUT and DEDS had a significant association with awareness of airflow (ill-fitting mask).Apart from symptoms, we assessed dry eye objectively by TBUT and ST which makes our results more accurate. We included the ill-fitting masks in our analysis. This has not been considered by any of the previous studies. We found abnormal TBUT in 89 (23.2%) of the participants compared to abnormal ST in only 12(3.1%) mask wearers. This could possibly be explained by the poor diagnostic value of ST which may be due to reflex tearing leading to a false negative test.[13,14] We found only one study which measured non-invasive TBUT using an Oculus Keratograph 5M (Oculus, Wetzlar, Germany) in patients with dry eye disease among mask wearers. They carried out an initial measurement with the patient wearing a face mask and a second measurement without wearing the mask, and they concluded that face mask use decreases tear film stability in patients with moderate-to-severe dry eye.[15] Aksoy et al. assessed all patients upon initial clinical admission (T1), after wearing a mask for 8 hrs (T2), and after 15 days with specific instructions of tapping the (T3) mask and found that there was a significant difference between T1 and T2, and between T2 and T3 in TBUT (P<0.001), ST results (P<0.001).[16] In our study, TBUT was significantly associated with DEDS (Table 1).

An online survey reported mask-associated dry eye in 18.3% of participants in the general population.[17] A study done in the ophthalmology out patient showed 17.7% patients experienced symptoms of dry eye who had no previous dry eye with mask wearing.[18] A higher prevalence of dry eye symptoms (53.4%) has been reported in an Indian study during COVID among HCWs wearing mask.[19] All our patients used mask of which 145(37.8%) complained of burning sensation 105(27.3%) complained of dryness and 93 (24.2%) complained of irritation and the symptoms were significantly associated with TBUT and ST (Tables 1 and 2). Most studies have found worsening of DEDS with mask wear.[8,17,18,20,21] We did not ask for the worsening of DEDS. On the contrary, few studies have coded the improvement in DEDS with mask wear.[22] As this study participants were all from COVID wards, all participants used protective glasses and N95 masks. Hence, the upward flow of air may be trapped by their goggles and the vapor created in the protective glass during the long-time continuous wearing of N95 for 4-5 hours might have contributed to the improvement of DEDS. None of our Study participants used protective goggles. Another study showed only 0.8% reported a decrease in pre-existing dry eye symptoms following mask wear.[17] A study on mask wearers using contact lenses also showed reduction in dry eye symptoms in 1.2%.[18]

In the current study we did not find significant difference in DEDS, TBUT, and ST with age which is comparable to other studies.[18,19,22] However, most of the studies on dry eye show significant dry eye in elderly population.[17,23] This may be attributed to the smaller number (5.9%) of study participants above 40 years of age in this study. Female gender was significantly associated with DEDS, which is in sync with previous studies.[17,18,22]

Table 1: Association of tear film break up time with dry eye disease symptoms, gender, occupation, type of mask, duration, and airflow awareness

S. No			Tear Film Break up time n (%)		P-Value
			Normal 295(76.8)	Reduced 89(23.2)	
1		Burning present	98 (67.6)	47(32.4)	0.001
		Burning absent	197(82.4)	42(17.6)	
	Symptoms	Irritation present	61(65.6)	32(34.4)	0.003
		Irritation absent	234(80.4)	57(19.6)	
		Dryness present	66(62.9)	39(37.1)	<0.001
		Dryness absent	229(82.1)	50(17.9)	
2	**Gender**	Male	90 (30.5)	32 (36.0)	0.333
		Female	205 (69.5)	57 (64.0)	
3	**Occupation**	Doctors	124 (42.0)	33 (37.1)	0.225
		Nurses	112(38.0)	29 (32.6)	
		Attenders	112(38.0)	13 (14.6)	
		Others	33 (11.2)	14 (15.7)	
4	**Type of Mask**	Cloth	2 (0.7)	0 (0.0)	0.194
		Surgical	115 (39.0)	25 (28.1)	
		N95	70 (23.7)	22 (24.7)	
		Combined	108 (36.6)	42 (47.2)	
5	**Duration of mask wear in hours**	< 8 hours	89(30.2)	24(27.0)	0.561
		≥ 8 hours	206(69.8)	65(73.0)	
6	**Duration of mask wear in months**	≤12 months	200(67.8)	62(69.7)	0.740
		>12 months	95(32.2)	27(30.3)	
7	**Airflow Awareness n(%)**	Present	166 (56.3)	61 (68.5)	0.039
		Absent	129 (43.7)	28 (31.5)	

n: numbe of participants

All symptoms of dry eye were significantly more among doctors and nurses compared to attenders and technicians which may be due to the compulsory long duration of mask-wearing due to direct contact with the patients. Awareness of airflow of masks was more among doctors which could be attributed to their wearing N95 mask (Figure 2). We presume that N95 mask has a good approximation from all sides. However, if the superior clip is not pressed well, it may lead to upward airflow towards the eyes compared to another mask.

The prolonged use of a mask throughout the day increases the symptoms of discomfort and the sensation of dry eye.[16,18,19] Scalinci SZ et al., found those who reported wearing a face mask for at least 6 hours a day, at least 5 days a week (Group A: heavy mask users) showed a higher increase in their OSDI scores (P < 0.001), as compared to standard users (Group B: Standard mask users).[21] All participants in present the study had a minimum of 6 hours of mask-wearing. We found a significant burning of the eyes (p=.026) in those wearing masks for more 8 hours or more. Eye irritation was present in higher number with those wearing masks for 8 hours or more, though it was not significant (p=0.054). Those wearing masks for more than 12 months complained of significant dryness (p=0.00) (Table 3), though association with TBUT was not significant (Table 1).

Mask especially if it is loose superiorly causes the awareness of upwards flow of air towards eye and is an indirect evidence of ill-fitting mask. We had 227(59.1%) participants who were aware of airflow upwards from mask. Awareness of airflow was significantly associated with TBUT and DEDS (Tables 1 and 3). Hence, we stress the fact that ill-fitting masks can cause ocular surface changes in the long run. Awareness of airflow was not influenced by the type of mask worn (Table 3). We believe that awareness of air flow may be related to attitude to proper mask wearing and observation of participant to air flow.

Many studies have not mentioned the type of mask participants used in the study per se. One of study in HCWs who wore N95 along with protective goggles interestingly found improved DEDS.[22] Moreover, Matusiak et al. documented that wearing surgical masks was linked to a significantly lower risk of adverse reactions than cloth mask or respirators.[24] This is supported by Roberge et al.

Table 2: Association of with Schirmer's test with dry eye disease symptoms, gender, occupation, type of mask, duration, and airflow awareness

S. No			Schirmer's Test at 5 minutes n (%)		P-Value
			Normal 372 (97.0)	Reduced 12 (3.2)	
1	**Symptoms**	Burning present	134 (92.4)	11(7.6)	< 0.001
		Burning absent	238 (99.6)	1(0.4)	
		Irritation present	89 (95.7)	4 (4.3)	0.495
		Irritation absent	283 (97.3)	8 (2.7)	
		Dryness present	94 (89.5)	11(10.5)	<0.001
		Dryness absent	278 (99.6)	1(0.4)	
2	**Gender**	Male	115 (30.9)	7 (58.3)	0.059
		Female	257 (69.1)	5 (41.7)	
3	**Occupation**	Doctors	151 (40.6)	6 (50.0)	0.074
		Nurses	140 (37.6)	1 (8.3)	
		Attenders	37 (9.9)	2 (16. 7)	
		Others	44 (11.8)	3 (25.0)	
4	**Type of Mask**	Cloth	2 (0.5)	0 (0.0)	0.005
		Surgical	140(37.6)	0 (0.0)	
		N95	85 (22.8)	7 (58.3)	
		Combined	145 (39.0)	5 (41. 7)	
5	**Duration of mask wear in hours**	< 8 hours	111(29.8)	2(16.7)	0.521
		≥ 8 hours	261 (70.2)	10(83.3)	
6	**Duration of mask wear in months**	≤12 months	257(69.1)	5(41.7)	0.059
		>12 months	115(30.9)	7(58.3)	
7	**Airflow Awareness n (%)**	Present	218 (58.6)	9 (75.0)	0.374
		Absent	154 (41.4)	3 (25.0)	

n: number of participants

who postulated that surgical mask use at a low-moderate work rate was not associated with clinically significant physiological impact.[25] Most of our study participants used various combinations of masks [150 (39%)]. We found significant burning(P<0.001) in the combined mask use followed by N95. We also tried to ascertain whether use of mask for <8 hours per day versus ≥8hours per day affects TBUT (Table 1). However, we did not find any significant difference.

Most studies support the increase in DEDS with the duration of use of visual display units.[8,19] We did not find any significant difference in DEDS, TBUT and ST with mobile and computer usage which was supported by other studies.[22] Martinez-Perez C, et al. found worsening of DEDS in soft contact lens wearers using the mask during COVID-19 pandemic. Around 18% of participants reported the worsening of already existing (61.5%) symptoms of dry eye.[26] We had very few [6(1.6%)] study participants who used contact lenses and there was no statistical difference in DEDS, TBUT and ST with contact lens users. A previous study demonstrated that "office eye syndrome" because of air conditioning in the office environment causes a decrease in TBUT time, causing eye irritation and an increase in dry eye symptoms.[27] We had 137(35.7%) participants who were exposed to the air conditioners, but no association was found with TBUT and ST.

Our study had few limitations. As the nurses were included it would have altered the gender distribution in the sample, though it is not clinically significant. Awareness of airflow may more be related to attitude to proper mask wearing and observation of participant. We did not ask for the worsening of DEDS; hence our proportion of dry eye may be an overestimation and may include the cases who already had a previous dry eye. However, most participants were young, developed DEDS after they started wearing masks and hence unlikely to have pre-existing DED. We did not ask for the duration of wearing of each type of mask in the combined category, which might have given more information. We used only DEDS, TBUT and ST for assessment of dry eye. Further studies may include a wider spectrum of measurements related to DED to investigate more thoroughly the effect of mask use on the ocular surface.

Table 3: Association of dry eye disease symptoms with gender, occupation, type of mask, airflow awareness and duration mask worn

		Dry eye disease Symptoms							
		Burning		Irritation		Dryness		Airflow awareness	
		Present	Absent	Present	Absent	Present	Absent	Present	Absent
Gender n (%)	Male 122(31.8)	62 (42.8)	60 (25.1)	38 (40.9)	84 (28.9)	41 (39.0)	81 (29.0)	90 (39.6)	32 (20.4)
	Female 262(68.2)	83 (57.2)	179 (74.9)	55 (59.1)	207 (71.1)	64 (61.0)	198 (71.0)	137 (60.4)	125 (79.6)
P- value		<0.001		0.031		0.060		< 0.000	
Occupation n (%)	Doctors 157(40.9)	80 (55.2)	77 (32.2)	50 (53.8)	107 (36.8)	36 (34.3)	121 (43.4)	110 (48.5)	47 (29.9)
	Nurses 141(36.7)	28 (19.3)	113 (47.3)	22 (23.7)	119 (40.9)	28 (26.7)	113 (40.5)	72 (31.7)	69 (43.9)
	Attenders 39(10.2)	15 (10.3)	24 (10.0)	13 (14.0)	26 (8.9)	15 (14.3)	24 (8.6)	19 (8.4)	20 (12.7)
	Others 47(12.2)	22 (15.2)	25 (10.5)	08 (8.6)	39 (13.4)	26 _(24.8)	21 (7.5)	26 (11.5)	21 (13.4)
P- value		<0.001		0.003		<0.001		0.004	
Type of Mask n (%)	Cloth 02(0.5)	0 (0.0)	02 (0.8)	0 (0.0)	02 (0.7)	01 (1.0)	01 (0.4)	0 (0.)	02 (1.3)
	Surgical 140(36.5)	26 (17.9)	114 (47.7)	30 (32.3)	110 (37.8)	29 (27.6)	111 (39. 8)	78 (34.4)	62 (39.5)
	N95 92(24.0)	49 (33.8)	43 (18.0)	26 (28.0)	66 (22.7)	29 (27.6)	63 (22.6)	57 (25.1)	35 (22.3)
	Combined 150(39.0)	70 (48.3)	80 (33.5)	37 (39. 8)	113 (38.8)	46 (43.8)	104 (37.3)	92 (40.5)	58 (36.9)
	P- Value	< 0.001		0.624		0.105		0.267	
Airflow Awareness n (%)	Present	97 (66.9)	130 (54.4)	66 (71.0)	161 (55.3)	70 (66.7)	157 (56.3)	NA	NA
	Absent	48 (33.1)	109 (45.6)	27 (29.0)	130 (44.7)	35 (33.3)	122 (43.7)	NA	NA
	P- Value	0.016		0.008		0.065			
Mask worn n(%)	< 8 hours 113 (29.4)	33 (22.8)	80 (33.5)	20 (21.5)	93 (32.0)	30 (28.6)	83 (29.7)		
	≥ 8 hours 271 (70.6)	112 (77.2)	159 (66.5)	73 (78.5)	198 (68.0)	75 (71.4)	196 (70.3)		
	P-Value	0.026		0.054		0.821			
Mask worn n(%)	≤12 month 262(68.2)	91 (62.8)	171 (71.5)	63 (67.7)	199 (68.4)	57 (54.3)	205 (73.5)		
	> 12 month 122 (31.8)	54 (37.2)	68 (28.5)	30 (32.3)	92 (31.6)	48 (45.7)	74 (26.5)		
	P-Value	0.073		0.908		<0.001			

n: number of participants

Table 4: Showing association of type of mask with occupation and duration mask worn

		No of Participants wearing Type of Mask n (%)				P-Value
		Cloth 2(0.5)	Surgical 140(36.5)	N95 92(24.0)	Combined 150(39.0)	
Occupation	Doctors	0(0)	14(10)	75(81.5)	68(45.3)	0.000
	Staff Nurses	1(50.0)	96(68.6)	13(14.1)	31(20.7)	
	Attender	0(0)	21(15.0)	1(1.1)	17(11.3)	
	Others (Lab Technician, Secretary)	1(50.0)	9(6.4)	3(3.3)	34(22.7)	
Duration Mask worn	<8 hours	1(50.0)	57(40.7)	15(16.3)	40(26.7)	0.000
	≥8 hours	1(50.0)	83(59.3)	77(83.7)	110(73.3)	
Duration Mask worn	≤12 months	2(100)	123(87.9)	49(53.3)	88(58.7)	0.000
	>12 months	0(0)	17(12.1)	43(46.7)	62(41.3)	

n: number of participants

5. Conclusions

Twenty-three percent of HCWs who wore masks had dry eyes, which is higher than that of general population. Wearing an improperly fitting mask can lead to dry eye. The dry eye symptoms are likely to be more in females, doctors, and nurses. As mask use is likely to last for months or even years, the prevalence of dry eye may increase significantly in the coming years. HCWs should be counseled regarding proper mask-wearing and simple tips as placement of adhesive tape across the mask at the bridge of the nose can prevent damage to the ocular surface. This will protect against dry eye symptoms and airborne transmissions.

6. Source of Funding

Nil.

7. Conflicts of Interest

There are no conflicts of interest.

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