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Facemask Associated Dry Eyes among Healthcare Workers during COVID-19 Pandemic, Jeddah, Saudi Arabia

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ABSTRACT

Background: The use of facemasks is a key preventive measure against the COVID-19 pandemic. Wearing a facemask for long periods can cause mask-associated dry eyes. This study explored the prevalence of facemask-related dry eyes (MADE) and associated factors. *Methods:* This study was cross-sectional, carried out on healthcare workers in Primary Healthcare Centers (PHCs) in Jeddah, Saudi Arabia. Descriptive statistics were performed. Chi-Square was used to evaluate the association between determinant and outcome variables. P-value < 0.05 was considered for significance. Regression analysis was applied to identify the contribution of independent factors to the outcomes. *Results:* Our study got a 91% response rate. The prevalence of mask-associated dry eyes was 70.9%. Participants aged 31-40 years had almost three times more likelihood to develop MADE (OR: 2.98; 95% CI: 1.493-5.947), and those aged 41-50 years had 2.54 odds of developing MADE (OR: 2.54; 95% CI: 1.090-5.924). Time spent on digital screens (> 4 hours) was 2.38 times more associated with MADE, while radiology staff, medical specialists, medical consultants and managerial team were less likely (OR=0.097, OR= 0.257, OR=0.222, and OR=0.290, respectively) of developing MADE. There was no statistically significant association of MADE with pre-existing eye problems (p>0.05). *Conclusion:* The prevalence of mask-associated dry eyes was high. Increased age and screen time were significant independent factors associated with risks for MADE, while being a radiology staff and managerial team member, medical specialists, and medical consultants were associated with lower risks for MADE than other healthcare workers.

Keywords: Face Mask, Dry eyes, COVID-19, Healthcare Workers, Dry Eye Disease

1. INTRODUCTION

Dry eye disease (DED) is an increasingly concerning public health problem resulting in ocular discomfort, fatigue and visual disturbance that affects the quality of life in all aspects, impacting physical, social, and psychological functioning, daily activities, and workplace productivity (Al-dolat et al., 2022; Toth & Jokić-Begić, 2020; Uchino & Schaumberg, 2013). It is one of the most

prevalent ocular surface diseases in the world. In epidemiological studies performed globally, DED prevalence ranged from 5 to 64% (Noor, 2018; Shanti et al., 2020; Uchino & Schaumberg, 2013). DEDs prevalence in Al-Ahsa, Saudi Arabia, was found to be 32.1% (Alshammari et al., 2021). Risk factors for DED include age, inflammatory diseases, medications (antihistamines, contraceptives), lifestyle and environmental factors (Scalinci et al., 2021). Wearing facemasks has been mandated as one of the measures to control the COVID-19 pandemic. This has led to some dry eye-related concerns; wearing facemasks change the air dynamics by reducing air's spread and directing it upward toward the eyes. Apart from causing fogged glasses, it quickens tear film evaporation, drying the ocular surface (Arriola-Villalobos et al., 2021; D'Souza et al., 2022; Esen Baris et al., 2022). Prolonged use of masks can lead to several complaints like headache, difficulty in breathing, skin irritation, sweating, and ocular irritation (Gurnani& Kaur, 2021; Pandey & Sharma, 2021).

In one study conducted involving 2,447 people with symptoms of dry eyes, 26.9 % of participants reported exacerbation of dry eye symptoms due to wearing facemasks (Boccardo, 2022). Other studies found that prolonged and consistent facemask use was associated with increased Ocular Surface Disease Index scores and increased ocular surface inflammation (D'Souza et al., 2022; Scalinci et al., 2021).

Since the use of facemasks is a key measure for controlling the COVID-19 pandemic, discomforts related to wearing facemasks might have negatively affected adherence to the application of the measure. There are no local data in Saudi Arabia about facemask association with dry eyes for the facemask wearers without DED or an increase in the symptoms for the facemask wearers with DED. Therefore, we conducted this study to evaluate the prevalence, identify factors associated with, and assess the severity of facemask-related dry eyes among health workers in Primary Health Care Centers (PHCs), Jeddah, Saudi Arabia. We also investigated the relationship between facemask wearing hours and dry eyes.

2. METHODS

Study Design and participants

This study was an analytical cross-sectional conducted on healthcare workers of the Ministry of health at PHCs of Jeddah city from February 2022 to May 2022. Physicians, nurses, pharmacists, radiology staff members, laboratory specialists, dental professionals and managerial staff members were all included in this study.

Sampling

The target sample size was calculated using Raosoft software with a 5% margin error, and 95% confidence interval was 377. Then the researcher will add 10% to compensate for item non-response. The total sample size was 415. A multistage stratified sampling technique was used. We stratified 47 PHC of Jeddah city into five strata (North, East, West, South, and Central). Three centers were randomly selected from each stratum using a simple random technique to make 15 centers. The total sample size of 415 was divided equally into 15 centers. From each center, 28 participants were selected by systematic random sampling.

Data collection tool

The study questionnaire was based on the internationally recognized, validated Standard Patient Evaluation of Eye Dryness Questionnaire (SPEED). Our study questionnaire consists of three parts. The first collects socio-demographic data (age, sex, nationality, health occupation category). The second part consists of elements of the Standard Patient Evaluation of Eye Dryness Questionnaire (SPEED), which involves four sections about eye symptoms, frequency, severity and use of lubricating eye drops. The third section contains questions about Mask Associated Dry Eyes (MADE). Participants who reported symptoms of ocular discomfort were asked if these symptoms were better, worse, or stayed the same, while wearing a face mask. The presence of dry eye symptoms at least sometimes and become worse when using a facemask was considered MADE, including people who had symptoms and those whose symptoms became worse the facemask (Pandey & Sharma, 2021). Instead, people who had no symptoms and whose symptoms didn't worsen were not considered MADE patients. The questionnaire was translated from English to the Arabic language. Questionnaires were distributed to the selected healthcare workers through a google form by SMS together with an invitation to participate.

Data analysis

Data were analyzed using SPSS version 26. Descriptive statistics were performed. Chi-Square was used to evaluate the association between determinant and outcome variables. P-value < 0.05 was considered for significance. Regression analysis was applied to adjust for confounding factors and identify each independent variable's contribution to the dependent variable.

3. RESULTS

Of 415 selected participants, 381 (91.8%) responded. Table 1 the frequency shows the demographics of the primary healthcare workers in Jeddah. Most were female (62.5%), aged 31-40 years (53.8%), Saudi (96.6%) and nurses (24.7%) (Table 1).

Table 1 Socio-economic and demographic characteristics

Variables	Categories	Frequency	Percent
Gender	Female	238	62.5
	Male	143	37.5
Age	18-30	80	21.0
	31-40	205	53.8
	41-50	65	17.1
	51-60	31	8.1
Nationality	Non-Saudi	13	3.4
	Saudi	368	96.6
Occupation	General Practitioner	39	10.2
	Medical resident	70	18.4
	Dentist	22	5.8
	Nurses	94	24.7
	Pharmacists	16	4.2
	Radiology staff	8	2.1
	Laboratory	29	7.6
	Medical Specialist	29	7.6
	Medical Consultant	28	7.3
	Managerial	44	11.5
	Social worker	2	0.5

We found that MADE prevalence was 70.9%. Most (30.4%) participants had eye dryness, grittiness, or scratchiness, followed by eye fatigue (24.9%) and eye burning (10.2%) at the time of data collection. Within the past 3 days, 41.2% had eye dryness, grittiness, or scratchiness, followed by eye fatigue (31.2%, and had eye burning (24.9%). During previous 3 months, the majority (53.8%) had dryness, grittiness, or scratchiness, followed by eye fatigue (41.5%) and burning or watering (40.2%). Mild and severe dry eye symptoms were reported by 47%, and 35.4%, respectively (Table 2).

Table 2 Prevalence of MADE and dry eye symptoms among participants

Variables		Frequency	Percent
No MADE		111	29.1
MADE		270	70.9
Dryness, grittiness Scratchiness now	No	265	69.6
	Yes	116	30.4
Dryness Grittiness Scratchiness within past 3 Days	No	224	58.8
	Yes	157	41.2
Dryness Grittiness Scratchiness Within Past 3 Months	No	176	46.2
	Yes	205	53.8
Soreness or irritation Now	No	351	92.1
	Yes	30	7.9
Soreness irritation within past 3 days	No	341	89.5
	Yes	40	10.5

Soreness irritation within past 3 months	No	298	78.2
	Yes	83	21.8
Burning or watering Now	No	342	89.8
	Yes	39	10.2
Burning or watering within past 3 days	No	286	75.1
	Yes	95	24.9
Burning or watering within past 3 months	No	228	59.8
	Yes	153	40.2
Eye fatigue now	No	297	78.0
	Yes	84	22.0
Eye fatigue within past 3 days	No	262	68.8
	Yes	119	31.2
Eye fatigue within past 3 months	No	223	58.5
	Yes	158	41.5
Severity of SPEED	Mild dry eye symptoms	179	47.0
	Moderate dry eye symptoms	67	17.6
	Severe dry eye symptoms	135	35.4

The prevalence of active eye infection was 1.6%, hypotensive eye drops usage was 3.7%, and 18.4% of participants were diagnosed with dry eyes. Of all participants, 3.1% had autoimmune or neurogenic disease and 9.4% had a history of intraocular surgery. Of participants, 54.1% wore the mask for less than 6 hours and 72.7% spent 4 hours in front of the screens of digital devices (Table 3).

Table 3 Pre-existing eye problems among participants

Variables	Categories	Frequency	Percent
Active eye infections	No	375	98.4
	Yes	6	1.6
Anti-histamine or hypotensive eye drops	No	367	96.3
	Yes	14	3.7
Diagnosed with dry eyes	No	311	81.6
	Yes	70	18.4
Autoimmune or neurogenic disease	No	369	96.9
	Yes	12	3.1
History of intraocular surgery	No	345	90.6
	Yes	36	9.4
Duration of mask wearing	<6 hours	206	54.1
	6-12 hours	156	40.9
	>12 hours	19	5.0
Duration in front of screen	<2 hours	28	7.3
	2-4 h09rs	76	19.9
	>4 hours	277	72.7

Mask wearing had a significant correlation with frequency of eye dryness, grittiness and scratchiness (p=0.005), eye soreness or irritation (p=0.000) and severity of eye Dryness, Grittiness or Scratchiness (p=0.002) (Table 4). Eye dryness, grittiness and scratchiness were constant for most participants who wore masks for less than 2 hours (61.5%), and Soreness or Irritation was

persistent for participants who wore masks for less than 2 hours (57.1%), and 6-12 hours (42.9%), while it was often in 50% of those who wore masks for 6-12 hours. On the other hand, dryness, grittiness or scratchiness were mostly bothersome with less than 2 hours wearing masks (62.1%), uncomfortable with 6-12 hours wearing masks (50.7%), and intolerable (40%) with both less than 2 hours and 6-12 wearing masks.

Table 4 Correlation of mask wearing hours with frequency and severity of symptoms in participants with pre-existing eye problems

Symptoms	Frequency	Duration of mask wearing			p-value
		<6 hrs	6-12 hrs	>12 hrs	
Dryness Grittiness Scratchiness	Never	65 56.0%	50 43.1%	1 0.9%	0.005
	Sometimes	86 53.8%	68 42.5%	6 3.8%	
	Often	39 49.4%	29 36.7%	11 13.9%	
	Constant	16 61.5%	9 34.6%	1 3.8%	
Soreness or Irritation	Never	139 60.2%	88 38.1%	4 1.7%	0.000
	Sometimes	44 41.5%	53 50.0%	9 8.5%	
	Often	19 51.4%	12 32.4%	6 16.2%	
	Constant	4 57.1%	3 42.9%	0 0.0%	
Burning or Watering	Never	104 57.5%	70 38.7%	7 3.9%	0.100
	Sometimes	76 52.4%	64 44.1%	5 3.4%	
	Often	22 50.0%	16 36.4%	6 13.6%	
	Constant	4 36.4%	6 54.5%	1 9.1%	
Eye Fatigue	Never	105 59.3%	66 37.3%	6 3.4%	0.211
	Sometimes	68 51.1%	57 42.9%	8 6.0%	
	Often	25 48.1%	22 42.3%	5 9.6%	
	Constant	8 42.1%	11 57.9%	0 0.0%	
Dryness, Grittiness or Scratchiness	SEVERITY				
	No Problems	73 54.9%	59 44.4%	1 0.8%	0.002
	Tolerable	83 58.0%	53 37.1%	7 4.9%	
	Uncomfortable	30 42.3%	36 50.7%	5 7.0%	
	Bothersome	18 62.1%	6 20.7%	5 17.2%	

	Intolerable	2 40.0%	2 40.0%	1 20.0%	
	No Problems	143 57.7%	98 39.5%	7 2.8%	
	Tolerable	39 49.4%	31 39.2%	9 11.4%	
Soreness or Irritation	Uncomfortable	19 44.2%	21 48.8%	3 7.0%	0.074
	Bothersome	4 40.0%	6 60.0%	0 0.0%	
	Intolerable	1 100.0%	0 0.0%	0 0.0%	
	No Problems	114 57.6%	76 38.4%	8 4.0%	
	Tolerable	69 51.9%	56 42.1%	8 6.0%	
Burning or Watering	Uncomfortable	16 43.2%	18 48.6%	3 8.1%	0.719
	Bothersome	6 50.0%	6 50.0%	0 0.0%	
	Intolerable	1 100.0%	0 0.0%	0 0.0%	
	No Problems	118 58.4%	76 37.6%	8 4.0%	
	Tolerable	66 52.0%	52 40.9%	9 7.1%	
Eye Fatigue	Uncomfortable	15 45.5%	17 51.5%	1 3.0%	0.493
	Bothersome	5 33.3%	9 60.0%	1 6.7%	
	Intolerable	2 50.0%	2 50.0%	0 0.0%	

Table 5 shows that MADE is significantly associated with more severe dry eye symptom, with severe and moderate symptoms being the most reported (87.4% and 85.1%, respectively) (p=0.000). Table 6 shows the association between MADE and socio-economic and demographic characteristics. Age (p=0.000), occupation (p=0.000), duration of mask wearing (p=0.001), and time spent in front of the screens (p=0.000) significantly correlated with MADE. Most participants with MADE were aged 31-40 years (79%) and 41-50 years (67.7%). Of all medical residents, 90% had MADE, followed by dentists (81.8%), general practitioners (79.5%), and laboratory workers (75.9%), and while social workers were the least affected (50%).

Table 5 Frequency Distribution of MADE among categories of SPEED

Variables	Categories	MADE		p-value
		No MADE	MADE	
Total Speed	Mild dry eye symptoms	84 46.9%	95 53.1%	0.000*
	Moderate dry eye symptoms	10 14.9%	57 85.1%	
	Severe dry eye symptoms	17 12.6%	118 87.4%	

**Highly significant if p-value < 0.01; MADE: Mask Associated Dry Eye*

Table 6 Association of MADE with socio-economic and demographic characteristics and pre-existing eye problems

Variables	Categories	MADE		P-value
		No MADE	MADE	
Gender	Female	61	177	0.052
		25.6%	74.4%	
	Male	50	93	
		35.0%	65.0%	
Age	18-30	27	53	0.000**
		33.8%	66.3%	
	31-40	42	163	
		20.5%	79.5%	
	41-50	21	44	
		32.3%	67.7%	
	51-60	21	10	
		67.7%	32.3%	
Nationality	Non-Saudi	7	6	0.046*
		53.8%	46.2%	
	Saudi	104	264	
		28.3%	71.7%	
Occupation	General Practitioner	8	31	0.000**
		20.5%	79.5%	
	Medical resident	7	63	
		10.0%	90.0%	
	Dentist	4	18	
		18.2%	81.8%	
	Nurses	27	67	
		28.7%	71.3%	
	Pharmacists	5	11	
		31.3%	68.8%	
	Radiology staff	5	3	
		62.5%	37.5%	
	Laboratory	7	22	
		24.1%	75.9%	
	Medical Specialist	13	16	
		44.8%	55.2%	
	Medical Consultant	16	12	
		57.1%	42.9%	
	Managerial	18	26	
		40.9%	59.1%	
	Social worker	1	1	
		50.0%	50.0%	

***Highly significant if p-value < 0.01; *Significant if p-value < 0.05; MADE: Mask Associated Dry Eye*

Table 7 shows the association of made with pre-existent eye problems, duration of mask wearing hours and screen hours. Duration of mask wearing hours (p=0.001) and screen hours (p=0.000) had a statistically significant association with MADE. Mask wearing for more than 12 hours correlated with 100% risks for MADE. The risk for MADE increased with time spent in front of the screen, from 46.4% (less than 2 hours of screen time) to 77.6% (more than 4 hours of screen time) (Figure 1 and 2). There was no statistically significant association of MADE with pre-existing eye problems.

Table 7 Association of MADE with pre-existent eye problems, duration of mask wearing hours and screen hours

Variables		MADE		P-value
		No MADE	MADE	
Active eye infections	No	109 29.1%	266 70.9%	0.819
	Yes	2 33.3%	4 66.7%	
Anti-histamine or hypotensive eye drops	No	107 29.2%	260 70.8%	0.962
	Yes	4 28.6%	10 71.4%	
Diagnosed with dry eyes	No	87 28.0%	224 72.0%	0.294
	Yes	24 34.3%	46 65.7%	
Autoimmune or neurogenic disease	No	106 28.7%	263 71.3%	0.332
	Yes	5 41.7%	7 58.3%	
History of intraocular surgery	No	101 29.3%	244 70.7%	0.851
	Yes	10 27.8%	26 72.2%	
Duration of mask wearing	<6 hours	53 25.7%	153 74.3%	0.001*
	6-12 hours	58 37.2%	98 62.8%	
	>12 hours	0 0.0%	19 100.0%	
Duration in front of screen	<2 hours	15 53.6%	13 46.4%	0.000**
	2-4 hours	34 44.7%	42 55.3%	
	>4 hours	62 22.4%	215 77.6%	

***Highly significant if p-value < 0.01; *Significant if p-value < 0.05; MADE: Mask Associated Dry Eye*

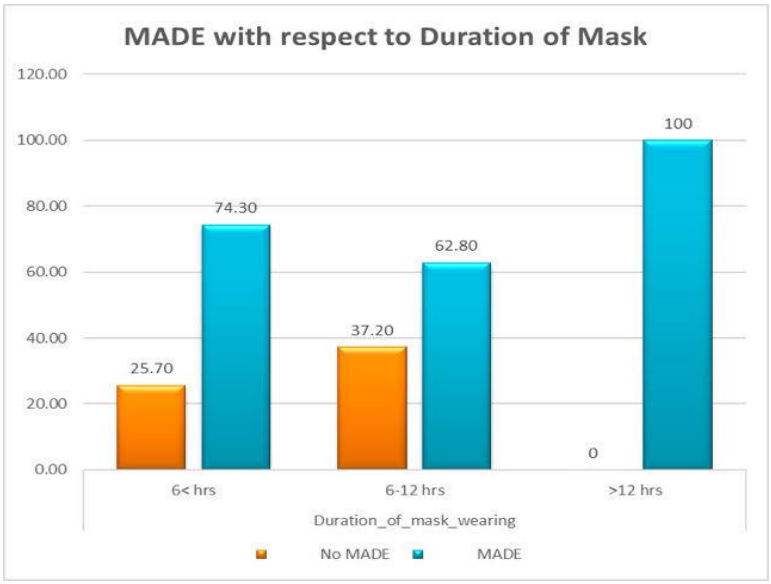

Figure 1 Association of MADE with the duration of mask wearing hours

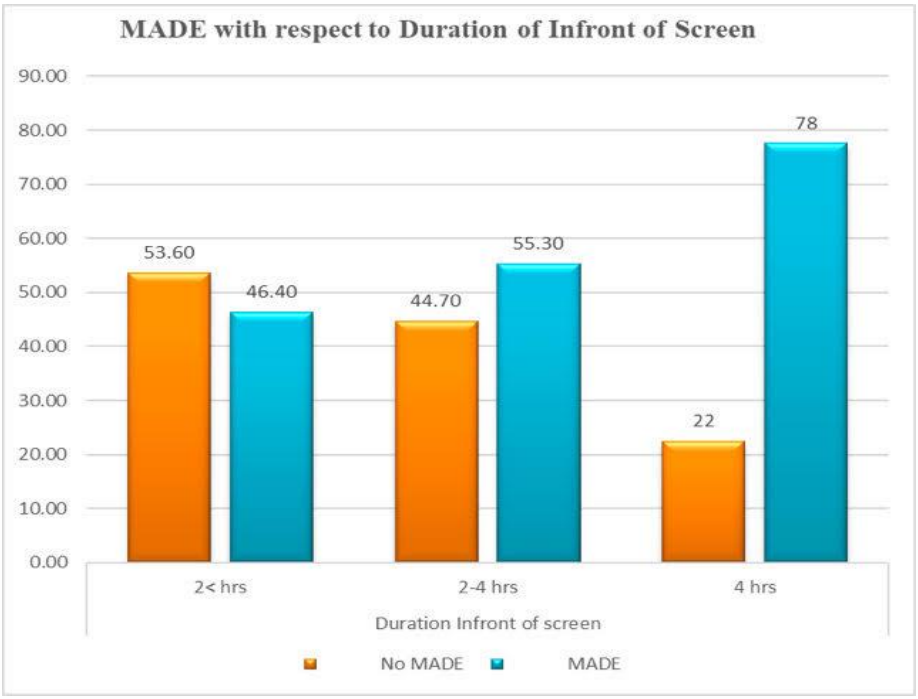

Figure 2 Association of MADE with the duration spent in front of the screens

Logistic regression analysis showed that age, occupation and screen time were significant independent factors associated with MADE (Table 8). Participants aged 31-40 years had almost three times more likelihood to develop MADE (OR: 2.98; 95% CI: 1.493-5.947) and those aged 41-50 years had 2.54 odds of developing MADE (OR: 2.54; 95% CI: 1.090-5.924). Duration in front of screen (> 4 hours) was 2.38 times more associated with MADE, while radiology staff, medical specialists, medical consultants and managerial team were less likely (OR=0.097, OR= 0.257, OR=0.222, and OR=0.290, respectively) of developing MADE.

Table 8 Logistic Regression Model of MADE

Factors	p-value	OR	95% C.I. for OR	
			Lower	Upper
Age (Ref: 18-30)	0.002*			
31-40	0.002*	2.980	1.493	5.947

41-50	0.031*	2.541	1.090	5.924
51-60	0.674	0.788	0.260	2.387
General practitioner (Ref)	0.009*			
Medical resident	0.478	1.520	0.478	4.827
Dentist	0.870	0.890	0.221	3.579
Nurses	0.058	0.375	0.136	1.035
Pharmacists	0.116	0.315	0.074	1.331
Radiology staff	0.008*	0.097	0.017	0.548
Laboratory	0.667	0.755	0.209	2.720
Medical Specialist	0.022*	0.257	0.081	0.820
Medical Consultant	0.023*	0.222	0.061	0.814
Managerial	0.028*	0.290	0.096	0.876
Social worker	0.400	0.289	0.016	5.210
Duration_infront_of_screen (Ref: <2 hours)	0.006*			
Duration_infront_of_screen (2-4 hours)	0.947	0.967	0.361	2.591
Duration_infront_of_screen (> 4 hours)	0.066	2.381	0.946	5.996
Constant	0.533			

**Significant if p-value < 0.05; OR: Odds Ratio; CI: Confidence interval*

4. DISCUSSION

Among measures taken to contain the COVID-19 pandemic, facemasks were mandated for anyone, including healthcare professionals, while at work. This move was based on the COVID-19 transmission route, including respiratory droplets and aerosols. However, healthcare professionals, who spent long hours at work, had to wear facemasks for a long time, resulting in complications, including dry eyes. This study determined the prevalence of; identified factors associated with, and assessed the severity of facemask-related dry eyes and investigated the relationship between facemask wearing hours and dry eyes among healthcare workers in Primary Health Care Centers (PHCs), Jeddah, Saudi Arabia. Our study is the first to explore MADE among PHC workers in Jeddah, and the results will help understand the dry eye burden among the PHC workers and be used to establish measures addressing it, while maintaining facemask usage as COVID-19 prevention, in order to improve healthcare service quality provided at the PHCs in Jeddah.

Our study found that the prevalence of MADE among the PHC workers was 70.9%. This finding was close to the prevalence of 70% (Dag et al., 2022) and 71.7% (Al-dolat et al., 2022) reported by previous studies. Most participants of our study had symptoms of eye dryness, grittiness, scratchiness, eye fatigue, and eye burning or watering. These symptoms have been documented among healthcare providers who reported facemask-associated dry eyes. It was documented that ocular surface dry spots, discomfort and irrigation resulted from prolonged surgical mask wearing (Pandey & Sharma, 2021). Prolonged facemask wearing has been found to be associated with dry eyes or dry eye symptoms deterioration in both healthcare professionals and COVID-19 patients (Dag et al., 2022; Giannaccare et al., 2020; Pandey & Sharma, 2021). This implies that our findings of facemask use for 6-12 hours among 40.9% of our participants might have contributed to the higher prevalence of MADE. Another study is consistent with our study with its finding of a significant association between facemask use duration and ocular pain (Erogul et al., 2022).

Another study evaluating the impacts of facemasks on ocular surface found that eye redness, burning, pain, and tingling were the most common symptoms (Erogul et al., 2022). Facemasks change airflow when exhaling and may limit lower eyelid movement, leading to increased tears' evaporation and subsequent dry eye symptoms (Erogul et al., 2022; Giannaccare et al., 2020). In addition, facemask wearing causes discomfort leading to frequent eye rubbing that can further worsen dry eye symptoms. Concerning pre-existing eye problems, we found that most participants were diagnosed with pre-existing dry eyes, followed by those with a history of intraocular surgery.

Previous studies have cautioned people with pre-existing eye problems, especially DED, and ocular inflammatory conditions to avoid prolonged facemask wearing (Erogul et al., 2022; Giannaccare et al., 2020). In addition, prolonged facemask wearing was found to be associated with allergic conjunctivitis, worsening tear film breakup time increasing dry eye symptoms (Arriola-Villalobos et al., 2021; Esen Baris et al., 2022). Aligning with the literature, our study revealed that facemask positively correlated with the frequency and severity of eye symptoms. We 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 eye

problems. Facemask wearing for 6-12 hours was the most correlated with worse and constant symptoms. Our findings are also supported by another study from China that reported worsening symptoms in patients with pre-existing eye diseases (Fan et al., 2022). We found that there was a significant association of facemask usage with dry eye symptoms, with most participants reporting moderate and severe symptoms. These results agree with another study that found constant facemask use to increase ocular surface disease index (OSDI) scores (Scalinci et al., 2021), and worsening symptoms among contact lens users leading to frequent contact lenses removal after using facemask (Martinez-Perez et al., 2021).

The study conducted in China also found that prolonged facemask wearing, age, female gender, education, and use of eyeglasses and contact lenses were associated with MADE in healthy individuals (Fan et al., 2022). We similarly found that age, occupation, duration of mask wearing, and time spent digital screens significantly correlated with MADE. It was found that advanced age was a risk factor for MADE (Dag et al., 2022). Prolonged facemask wearing impact reported in the literature was emphasized by our study, indicating that 100% of participants who wore facemasks for more than 12 hours had MADE. Most participants of our study with MADE were in there 40s. The most affected were all medical residents, followed by dentists, general practitioners, and laboratory workers. These findings, coupled with the positive correlation of screen time spent on digital devices with MADE, may explain why these professionals were affected. Medical residents, who were the most affected (90%), spend a lot of time reading as a part of their studies and most use computers, phones and other digital devices.

Another study found an association between digital eye strain and MADE (Krolo et al., 2021). Dentists' work environment is close-contact-based and indoors in an air-conditioned environment, similar to general practitioners, and laboratory workers. Increased indoor time and air-conditioned environment, as well as long time spent on digital screens, were found to be correlated with MADE (Al-dolat et al., 2022; Fan et al., 2022). It was reported that ophthalmology consultations have increased for dry eyes caused by spending more than 6 hours on digital screens during the pandemic (Pandey & Sharma, 2021). This indicates that our study participants (77.6%) who spent more than four hours on digital screens might be at increased risk for MADE. Though some studies have found a correlation between MADE and female gender (Al-dolat et al., 2022; Fan et al., 2022; Pandey & Sharma, 2021), our study didn't find a significant correlation.

Logistic regression analysis showed that age, occupation and screen time were significant independent factors associated with MADE. Digital screen time of more than 4 hours and 31-40 and 41-40 age groups were independent predictors of more odds of MADE, while radiology staffs, medical specialists, medical consultants and the managerial team had fewer odds to develop MADE. The reason for this might be because the workload is not as intense for these job types as other healthcare facility jobs, and they reserve some time off and go outdoor for different activities or go home when they remove masks. In addition, night shifts for most of these jobs are minimal to none and they don't have academic duties, which reduce the duration of wearing masks at work and time spent reading on digital devices, thus reducing their risks for MADE. These findings indicate that these factors are the most significant predictors of MADE compared to others that had correlated with dry eyes but lost significance in logistic regression. These results also agree with other previous studies that reported age and digital eye strain to be significantly associated with MADE (Al-dolat et al., 2022; Erogul et al., 2022; Krolo et al., 2021; Pandey & Sharma, 2021).

While facemask wearing remains important to control the COVID-19 pandemic, studies have suggested that the use of lubricating eye drops and limiting the time spent in air-conditioned settings may minimize symptoms (Al-dolat et al., 2022). Limiting time spent on digital screens, increased blinking, proper facemask wearing, removal of masks at home, and taking enough time to rest and sleep are recommended to minimize MADE symptoms (Al-dolat et al., 2022; Pandey & Sharma, 2021). Our study presents some limitations from cross-sectional and online design, which might lead to limited determination relationships due to the evaluation of exposure and outcomes at the same time. Being online, this study is prone to selection bias and over- or under-representation of data. Offline interview-based longitudinal studies are recommended and could confirm our results

5. CONCLUSION

We found that MADE prevalence was high (70.9%) among healthcare workers in Jeddah. We found a significant positive correlation between dry eye symptoms severity and frequency and facemasks. Age, occupation, duration of mask wearing, and time spent on digital screens also correlated with MADE. However, only age, occupation and time spent on digital screens were the independent predictors for MADE. These findings highlight the need to put measures to minimize MADE incidences by revising work schedules to ensure flexible working hours and enough rest for workers. This study indicated that facemask wearing worsens symptoms among people with pre-existing eye problems. Together with workers without pre-existing eye problems, the use of lubricating eye drops, limiting the time spent in air-conditioned settings, limiting time spent on digital screens, increased blinking,

proper facemask wearing, removal of masks at home, and taking enough time to rest and sleep are recommended to minimize MADE symptoms. There is also a need to raise awareness to increase outdoor time and consult ophthalmologists for eye care.

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Ethical approval

The study was approved by the Research Committee of the Saudi program of preventive medicine in Jeddah and the ethical research committee (IRB) (Ref. No: A01321) of the health directorate in Jeddah, Saudi Arabia

Author Contributions

Nada M. Alghamdi designed the study's conceptual framework and drafted the research proposal also did data collection and analysis. Then she wrote the manuscript draft.

Najlaa A. Mandoura contributed to designing the study's conceptual framework, revision of results, editing manuscript and supervised the research conduction.

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Conflicts of interest

The authors declare that there are no conflicts of interests.

Data and materials availability

All data associated with this study are present in the paper.

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