Original Article

DOI: 10.7860/JCDR/2022/58185.17068

Prevalence of Dry Eye Disease in Glass Industry Workers of Firozabad, Uttar Pradesh, India: A Cross-sectional Observational Study

Ophthalmology Section

SHEFALI MAZUMDAR[1], RAVINDRA KUMAR SINGH[2], SK SATSANGI[3], RENU AGARWAL[4]

ABSTRACT

Introduction: Dry eye disease is a rising occupational hazard in India. Firozabad, is known for its glass manufacturing work worldwide. As there is limited evidence available on dry eye prevalence in glass industry workers, the present study was undertaken.

Aim: To find out the prevalence and severity of Dry Eye Disease (DED) in glass industry workers of Firozabad, Uttar Pradesh, India.

Materials and Methods: The cross-sectional observational study was conducted in Department of Ophthalmology at Sarojini Naidu Medical College, Agra, Uttar Pradesh, India, from March 2020 to September 2021 among the glass industry workers at Firozabad. It was a field survey, conducted in the factories only. Ocular Surface Disease Index (OSDI) questionnaire was presented to 500 randomly selected glass industry workers to screen for dry eye disease. Based on subject's response to OSDI questionnaire, score was calculated and then evaluated with an OSDI chart to assess the magnitude of dry eye symptoms. The final diagnosis and grading of dry eye was done on the basis of Schirmer's test. Chi-square test was used to detect the association between variables. Statistical Package for Social Sciences (SPSS) software (version 28.0) was used for analysis. A p-value <0.05 was regarded as significant.

Results : In the present study, the overall dry eye prevalence in glass industry workers was 28%. Mild dry eye was present in 3.2% of workers, moderate dry eye in 16.8%, and severe dry eye was present in 8% of glass workers. There was significant association between dry eye and working hours (per day) in two different study groups (≤8 hrs and >8 hrs) (χ^2=20.9, p-value <0.001). There was also a significant association between the prevalence of dry eye and the years of exposure (in years) in the glass industry (χ^2=51.4, p-value <0.001).

Conclusion: Prevalence of dry eye in glass industry workers is significantly high. Glass industry workers should undergo regular eye checkups to pick up DED as the earliest.

Keywords: Duration of exposure, High temperature, Occupational hazard, Ocular surface disease index, Relative humidity, Schirmer's test

INTRODUCTION

The prevalence of dry eye disease is greatly influenced by geographic location, climate, working conditions, and lifestyle of the people and ranges from 5-34 % worldwide [1,2], while in India, it is 18.4 to 54.3% [3,4].

According to Dews Definition (2007) , Dry eye disease is a multifactorial disease of the tear film and ocular surface that results in symptoms of discomfort, visual disturbance, and tear instability with potential damage to the ocular surface. It is accompanied by increased osmolarity of the tear film and inflammation of the ocular surface [5].

Dry eye in glass workers is an occupational environment related ocular surface disease [6,7]. In the glass industry, a high amount of heat is generated by the furnace and the surrounding area's temperature is very high. This artificially controlled indoor environment with low humidity and high temperature might adversely affect the tear film physiology of the eyes of the majority of workers [8,9]. There is limited evidence available on dry eye prevalence in glass industry workers [10], so authors decided to conduct a study to determine the prevalence of dry eye in the glass industry workers of Firozabad, Uttar Pradesh, India.

MATERIALS AND METHODS

The cross-sectional observational study was conducted in Department of Ophthalmology at Sarojini Naidu Medical College, Agra, Uttar Pradesh, India, from March 2020 to September 2021 among the glass industry workers at Firozabad. Informed consent was taken from all the workers more than 18 years of age with atleast one year of exposure in glass factory. The Institutional Ethics Committee approved the study (SNMC/EC/2020-37).

Sample size calculation: The sample size was calculated by taking the prevalence of dry eye in factory workers (16.6%) among different occupational groups of Madhya Pradesh [11], at 95% confidence interval and 20% allowable error as follows:

$N=Z^2PQ/L^2$

Where N= Sample size

Z^2=1.96 (Constant)

P=16.6 % (prevalence)

Q=100-P=100-16.6=83.4

L=20% of P=20% of 16.6=3.32

After applying above formula N=483, which has been rounded off to 500 for analytical purposes.

Inclusion and Exclusion criteria: The glass industry workers >18 years of age at Firozabad were included in this study. Workers with active/acute ocular infection, contact lens users, those who underwent any previous anterior eye surgery (like cataract Sx, refractive surgery, penetrating keratoplasty, eye lid surgery) within last six months, workers on systemic medication for hypertension (diuretics, beta-blockers) and known cases of systemic diseases (like diabetes mellitus, thyroid disease, sjögren's syndrome) were excluded from the study.

Ocular Surface Disease Index (OSDI) Questionnaire

Screening for dry eye was done on the basis of OSDI questionnaire presented to 500 workers, selected from different glass factories, by a process of simple random sampling. The OSDI is a prevalidated questionnaire which includes 12 questions about the respondent's past week experience with the ocular symptoms, vision-related

function and environmental triggers [12]. The total OSDI score ranged from 0 to 100.The scores classified [12]:

- ≤12 as normal,
- 13-22 as mild,
- 23-32 as moderate,
- >33 as severe

Schirmer's Test

Thereafter, Schirmer's test using a standard 5×35 mm strip of Whatman-41 filter paper at normal room temperature in the factory itself was performed on all those with an OSDI score of more than 12. The final diagnosis and severity were based on Schirmer's test as follows [13]:

- Mild dry eye: 11 to 15 mm
- Moderate dry eye: 6 to 10 mm
- Severe dry eye: <5 mm

A comparison of two proportions was used to detect the difference in the prevalence of dry eye between two sets of working hours per day (≤8 hrs and >8 hrs). Symptoms related to dry eyes like grittiness, burning and eye fatigue were noted and analysed. Statistical analysis was also done to analyse the association between the prevalence of dry eye and the duration (in years) of exposure.

STATISTICAL ANALYSIS

Statistical analysis was performed using Statistical Package for Social Sciences (SPSS) software (SPSS Inc., Chicago, IL, USA) for Windows program version 28.0. Chi-square test was used to detect the association between the variables. A p-value <0.05 was regarded as significant.

RESULTS

The mean age of workers was 34.6±12.5 years in the present study. Baseline characteristics are mentioned in [Table/Fig-1]. On screening with OSDI questionnaire, out of 500 workers 360 (72%) had score less than 12 and considered normal and out of remaining 140 workers, 16 (3.2%) had mild DED (OSDI score 13-22), 84 (16.8%) had moderate (OSDI score 22-32) and 40 (8%) workers had severe DED (OSDI score >32) [Table/Fig-2]. Schirmer's test was performed in these 140 workers. On the basis of Schirmer's test, 18 workers (3.6%) have mild DED, 79 (15.8%) had moderate and 43 (8.6%) workers had severe DED. The overall prevalence of DED in glass industry in this study was 28% [Table/Fig-3].

Characteristics	n (%)
Gender	
Male	450 (90)
Female	50 (10)
Age (years)	
18-20	55 (11)
21-30	95 (19)
31-40	135 (27)
41-50	125 (25)
>50	90 (18)
Working hours/day	
≤8 hours	105 (21)
>8 hours	395 (79)
Duration of exposure (years)	
1-10	135 (27)
11-20	145 (29)
21-30	125 (25)
>30	95 (19)
Total	500

[Table/Fig-1]: Baseline characteristics.

OSDI score	Male		Female		Total	
	n	%#	n	%#	n	%
No dry eye	320	64	40	8	360	72
Mild dry eye	10	2	6	1.2	16	3.2
Moderate dry eye	80	16	4	0.8	84	16.8
Severe dry eye	40	8	0	0	40	8
Total	450	90	50	10	500	100
p-value	χ^2=20.9, p-value <0.001					

[Table/Fig-2]: Screening based on OSDI score [12].
#percentage of total study population; p-value <0.05 was considered as statistically significant

Schirmer's test	Male (n=450)		Female (n=50)		Total (500)	
	n	%	n	%	n	%
No dry eye*	320	64	40	8	360	72
Mild (10-15 mm)	13	2.6	5	1	18	3.6
Moderate (5-10 mm)	74	14.8	5	1	79	15.8
Severe (<5 mm)	43	8.6	0	0	43	8.6
Total	450	90	50	10	500	100
p-value	χ^2=12.77, p-value=0.0051					

[Table/Fig-3]: Grading of dry eye disease based on Schirmer's test [13].
*workers having OSDI score <12, were not subjected to Schirmer's test; p-value <0.05 was considered as statistically significant

In the present study, it was found that the prevalence of dry eye was more in higher age group [Table/Fig-4] (p-value <0.001). The dry eye prevalence in male workers was about 29% and in female workers was 20% [Table/Fig-5]. The prevalence of DED was found to be 11.4% in workers working ≤8 hours per day and 32.4% in those working >8 hrs per day. According to the comparison of two proportions (χ^2=18.1, p-value <0.001), there was a significant association between daily working hours and the prevalence of dry eye [Table/Fig-6].

Age (years)	Dry eye		No dry eye		Total	
	n	%#	n	%#	n	%
18-20	2	0.4	53	10.6	55	11
21-30	11	2.2	84	16.8	95	19
31-40	35	7.00	100	20	135	27
41-50	49	9.8	76	15.2	125	25
51-60	43	8.6	47	9.4	90	18
Total	140	28	360	72	500	100
p-value	χ^2= 54.4, p-value <0.001					

[Table/Fig-4]: Prevalence of dry eye according to age group.
#percentage of total study population; p-value <0.05 was considered as statistically significant

Gender	Dry eye		No dry eye		Total	
	n	%	n	%	n	%
Male	130	28.89	320	71.11	450	100
Female	10	20	40	80	50	10
p-value	χ^2=1.76, p-value=0.184					

[Table/Fig-5]: Prevalence of dry eye according to gender.

Working hours/day	Dry eye		No dry eye		Total	
	n	%	n	%	n	%
≤8 hrs	12	11.43	93	88.57	105	100
>8 hrs	128	32.41	267	67.59	395	100
p-value	χ^2=18.1, p-value <0.001					

[Table/Fig-6]: Association between dry eye and daily working hours.
p-value <0.05 was considered as statistically significant

A significant association was noted between the prevalence of dry eye and duration (in years) of exposure (χ^2=51.44, p-value <0.001). The prevalence rate rapidly increased from 11 workers (7.8%) in less than 10 years of exposure to 46 workers (32.8%) in the group having more than 30 years of exposure [Table/Fig-7]. The present

study shows that burning (11.8%) was the most common complaint of workers, followed by eye fatigue (7%) [Table/Fig-8].

Exposure (years)	Dry eye		No dry eye		Total	
	n	%	n	%	n	%
1-10	11	7.86	114	31.67	135	27
11-20	32	22.86	113	31.39	145	29
21-30	51	36.42	84	23.33	125	25
>30	46	32.86	49	13.61	95	19
Total	140	100	360	100	500	100
p-value	χ^2=51.44, p-value <0.001					

[Table/Fig-7]: Association between dry eye and years of working in a factory (exposure).

Symptoms	Male n (%)	Female n (%)	Total n (%)
Dryness/grittiness	42 (30)	4 (2.85)	46 (32.85)
Burning	55 (39.28)	4 (2.85)	59 (42.14)
Eye fatigue	33 (23.57)	2 (1.42)	35 (25)
Total	130 (92.85)	10 (7.14)	140 (100)

[Table/Fig-8]: Symptoms among the dry eye cases.
Among 500 study population, 140 workers (28%) had the symptoms of dry eye; Chi-square= 2.64; p-value=0.620

DISCUSSION

The present study used the OSDI questionnaire and Schirmer's test to diagnose the DED cases in the glass industry workers of Firozabad in their factories. The overall prevalence of DED in glass industry in this study was 28%. It was found that the prevalence of dry eye was more in higher age group. Male workers had a higher prevalence of DED as compared to females (29% vs 20%). There was a significant association between daily working hours of more than eight hours and the prevalence of dry eye. The prevalence rate of DED increased with increasing cumulative years of exposure. The most common complaint was burning sensation followed by eye fatigue.

The prevalence rate of DED as an occupational hazard in different studies was variable. Vasanth J et al., in a cross-sectional study conducted in different occupational sectors (software, construction, agriculture, transport and industrial) on 240 subjects reported an overall prevalence of 21% with the highest been in the software sector [14]. Rashid MA et al., reported the prevalence of dry eye of 64% in 1050 garment industry workers [15]. Bhatnagar KR et al. published a hospital-based cross-sectional study on 1890 patients and reported an overall prevalence of dry eye as 10.58 % [7]. Dubey G et al., had done a study on ocular morbidities among 140 glass factory workers of Firozabad and found prevalence of dry eye of 15.7% [10]. The disparity in dry eye prevalence among different studies is mainly due to different diagnostic criteria employed and the differences in the sample size. Chakma AK et al., conducted a hospital based study in Tripura medical college and reported the prevalence of dry eye as 3.1%. According to author, the reason attributed for low prevalence of DED was the high humidity normally prevalent in that geographical area. This suggests that relative humidity is inversely related to the prevalence of dry eye [16]. The prevalence of DED in the present study is much higher when compared to the prevalence in the general population of 6.5-6.8% as shown by Chatterji S et al., in a cross-sectional study [17].

The higher prevalence in the present study could be possibly explained by the low humidity and high temperature working environment of the subjects [9].

DED in glass workers is an occupational hazard, who are constantly exposed to heat, fumes and low humidity in the working environment. The eye can adapt and compensate for the tear hyper osmolarity and tear film instability in the early stages. However, if left untreated, a vicious cycle of inflammatory dry eye disease sets in, damaging the tear film and affecting the daily activities such as reading, driving, sports, and recreational activities [18]. The present study shows that burning (11.8%) was the most common complaint of glass industry workers, followed by eye fatigue (7.0%) supported by Bhatnagar KR et al., who conducted a hospital based cross-sectional study on 1890 subjects and burning of eyes was one of the commonest symptoms [7]. In the present study, it was also found that the prevalence of dry eye increases with the age of workers. Sixty five percent of workers (92/140) with DED, were between the age of 40-60 years while 69% of workers (97/140) had duration of exposure between 20-30 years. A similar outcome was reported by Attri S et al., where the prevalence of DED increased with age and was found to be maximum in the age group of 60-69 years [19]. The prevalence of DED was more in male workers as compared to female workers (29% vs 20%). High prevalence of male workers is due to the disparity in the numbers of male to female workers. Slighty low prevalence in males have been found in other studies [17,20]. This could be explained by the fact that DED is multifactorial and there are many confounding factors. A proactive approach to prevention becomes important, starting with educating glass factory workers about their working environment's risks and adverse effects on the eyes. The importance of proper safety equipment (eye wear), use of humidifiers at home or in the workplace, avoiding cigarette smoking which causes an additive effect on the progression of dry eye, taking frequent breaks to rest the eyes, and maintaining adequate hydration should be emphasised. In case of eye problems, early referral to an eye specialist must be followed. These measures would go a long way in dealing with this occupational hazard and reducing work productivity loss [20].

Limitation(s)

The limitations of the present study were small sample size, single centre study and non inclusion of Tear breakup time (TBUT) as it was not feasible to perform in the field. Author recommends further multicentric study with large sample size to increase the reliability and generalisability of the present study.

CONCLUSION(S)

This study is the only study done specifically in glass industry workers in the field to find the prevalence of dry eye disease. The prevalence of DED in glass industry workers was 28%, which was quite high. DED is therefore of major concern in glass workers and measures like patient education, health awareness, use of protective eye ware and regular eye check-ups should be conducted to pick up DED and provisions made for their treatment and early referral when required.

REFERENCES

[1] The epidemiology of dry eye disease: Report of the Epidemiology. Subcommittee of the International Dry Eye Workshop (2007). Ocul Surf. 2007;5(2):93-107.
[2] Ahn JM, Lee SH, Rim TH, Park RJ, Yang HS, Kim TI, et al.; Epidemiologic Survey Committee of the Korean Ophthalmological Society. Prevalence of and risk factors associated with dry eye: The Korea National Health and Nutrition Examination Survey 2010-2011. Am J Ophthalmol. 2014;158:1205-14.
[3] Gupta N, Prasad I, Jain R, D'Souza P. Estimating the prevalence of dry eye among Indian patients attending a tertiary ophthalmology clinic. Annals of Tropical Medicine and Parasitology. 2010;104(3):247-55.
[4] Sahai A, Malik P. Dry eye: Prevalence and attributable risk factors in a hospital-based population. Indian J Ophthalmol. 2005;53(2):87-91.
[5] International dry eye workshop subcommittee. The definition and classification of dry eye disease. Report of the definition and classification subcommittee of the International Dry Eye Work Shop (DEWS-2007). Ocul Surf. 2007;75-92.
[6] Rozanova E, Heilig P, Godniæ-Cvar J. The eye- a neglected organ in Environmental and occupational Medicine: An overview of known environmental and occupational non-traumatic effects on the eyes. Arh Hig Rada Toksikol. 2009;60:205-15
[7] Bhatnagar KR, Sapovadia A, Gupta D, Kumar P, Jasani H. Dry eye syndrome: A rising occupational hazard in tropical countries. Med J DY Patil Univ. 2014;7(1):13-18.
[8] Abusharha AA, Pearce EI. The effect of low humidity on the human tear film. Cornea. 2013;32(4):429-34. Doi: 10.1097/ICO.0b013e31826671ab. PMID: 23023409.
[9] Wolkoff P. External eye symptoms in indoor environments. Indoor Air. 2017;27:246-60.
[10] Dubey G, Pal S, Chattopadhayay S, Ranjan R, Pant K, Shahid Y, et al. Ocular morbidities among glass factory workers at district Firozabad, Uttar Pradesh, India. International Journal of Health Sciences. 2022;6(S2):7939-48.

[11] Choudhary P, Chalisgaonkar C, Lakhtakia S, Dwivedi A. Dry eye prevalence and attributable risk factors in the eastern Madhya Pradesh. Int J Med Sci Public Health. 2015;4(11):1556-61.
[12] Ozcura F, Aydin S, Helvaci MR. Ocular surface disease index for the diagnosis of dry eye syndrome. Ocular immunology and Inflammation. 2007;15(5):389-93.
[13] Brott NR, Ronquillo Y. Schirmer Test. In: StatPearls. Treasure Island (FL): StatPearls Publishing; 2022 Jan.
[14] Vasanth J, Varghese V, Gajalakshmi G. Incidence and prevalence of dry eye syndrome in different occupational sectors. J Clin Exp Ophthalmol. 2016;7:3(Suppl).
[15] Rashid MA, Teo CH, Mamun S, Ong HS, Tong L. Prevalence and risk factors of severe dry eye in Bangladesh-based factory garment workers. Diagnostics. 2020;10(9):634.
[16] Chakma AK, Varghese J, Roy M. Dry eye: A Clinical Study in a Hospital Based Population. Ind Med Gaz. 2013;319-22.
[17] Chatterjee S, Agrawal D, Sanowar G, Kandoi R. Prevalence of symptoms of dry eye disease in an urban Indian population. Indian Journal of Ophthalmology. 2021;69 (5):1061-66. Doi: 10.4103/ijo.IJO_1796_20.
[18] Vallinayagam M, Kumar R, Durairaj B, Adiyapatham S, Ravi T. Dry eye in welders of Puducherry: A rising occupational hazard. DJO. 2018;28;14-18.
[19] Attri S, Dwivedi J, Mithal S, Gupta A, Singh LK. Dry Eye-study of prevalence, associated risk factors and frequency of symptoms in Meerut District. J Evolution Med Dent Sci. 2019;8(45):3382-86.
[20] Uchino M, Uchino Y, Dogru M, Kawashima M, Yokoi N, Komuro A, et al. Dry eye disease and work productivity loss in visual display users: the Osaka study. Am J Ophthalmol. 2014;157(2):294-300.

PARTICULARS OF CONTRIBUTORS:
1. Assistant Professor, Department of Ophthalmology, SN Medical College, Agra, Uttar Pradesh, India.
2. Junior Resident, Department of Ophthalmology, SN Medical College, Agra, Uttar Pradesh, India.
3. Professor, Department of Ophthalmology, SN Medical College, Agra, Uttar Pradesh, India.
4. Professor, Department of Community Medicine, SN Medical College, Agra, Uttar Pradesh, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Shefali Mazumdar,
Assistant Professor, Department of Ophthalmology,
SN Medical College, Agra, Uttar Pradesh, India.
E-mail: shefalimazumdar@gmail.com

PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: Jun 09, 2022
- Manual Googling: Jul 15, 2022
- iThenticate Software: Aug 02, 2022 (19%)

ETYMOLOGY: Author Origin

AUTHOR DECLARATION:
- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. NA

Date of Submission: **Jun 03, 2022**
Date of Peer Review: **Jul 04, 2022**
Date of Acceptance: **Aug 04, 2022**
Date of Publishing: **Oct 01, 2022**