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Original Research Article

Prevalence and Demographic Profile of Individuals with Dry Eye Disease (DED) In Industrial Workers and its Correlation with Vitamin D Levels

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Abstract

Background: Dry Eye Disease (DED) is a multifactorial ocular surface disorder that manifest as tear film instability, ocular discomfort, and visual disturbances. The risk of DED is especially high in the industrial sector, where workers are regularly exposed to air pollutants, heat, dust, chemical irritants and the use of digital screens for long periods of time. In recent years there is growing evidence that vitamin D deficiency is linked to the pathogenesis and severity of DED.

Methods: The study was a cross-sectional observational study carried out in the OPD of ophthalmology department in ESIC Model hospital involving 220 industrial workers. The participants have been examined in detail with Ocular Surface Disease Index (OSDI), Schirmer test, and Tear Break-Up Time (TBUT). Serum 25-OHVitamin D levels were quantified and then correlated with parameters of dry eye. Data was analysed using SPSS software.

Results: Prevalence of DED based on OSDI scoring was 34%, abnormal TBUT was observed in 79.5% of the participants and Schirmer test was observed abnormal in 15.9% of the participants. Most of the subjects were deficient in vitamin D, and there was a significant positive correlation between the two tests (TBUT and Schirmer) and vitamin D levels ($p<0.001$). DED severity was significantly related to occupational exposure, long working hours, smoking, heat exposure and computer exposure.

Conclusion: DED is very common in industrial workers, and also has a strong correlation with vitamin D deficiency and work risk factors. Disease burden and ocular health outcomes could be decreased through early screening at work, preventive eye health practices, and vitamin D supplementation.

Keywords: Dry Eye Disease, Vitamin D Deficiency, Industrial Workers, OSDI, Tear Break-Up Time.

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Introduction

DED is a multifactorial disorder of the ocular surface and tear film that is characterised by a loss of tear film homeostasis and symptoms of the eye, including redness, burning, itching, and difficulty seeing, grittiness, and exhaustion [1]. The Tear Film and Ocular Surface Society Dry Eye Workshop II (TFOS DEWS II) identified four ocular surface characteristics that are all similar to have an important etiological role in the development of DED, tear film instability, hyperosmolarity, ocular surface inflammation, and neurosensory abnormalities [2].

The chronic nature and the major impact on the quality of life and productivity of work makes DED a major public health concern [3]. Patients usually complain of discomfort while reading, prolonged use of digital screens, driving and when exposed to irritants in the environment, causing a decrease in their level of efficiency in the job and their mental state [4]. The prevalence of DED is highly variable around the world, even within populations and geographic regions, and ranges from 18% to more than 40% in India, depending on the diagnostic criteria and type of population studied [5].

There are several environmental, occupational and lifestyle risk factors associated with the development and progression of DED [6]. High temperature, long duration of sunlight exposure, smoking, air pollution exposure, excessive wind exposure, and long duration of digital screen exposure have been highly correlated with tear film instability and damage to the ocular surface [7]. Industrial workers are a exposed group since they are frequently exposed to dust particles, chemical fumes, heat, low humidity and long working hours in extreme working environment. In past research, dry eye symptoms were more prevalent in factory workers and industrial laborers, due to their exposure to worst environmental conditions [8]. The number of employees who use computers and smartphones in the workplace has risen, ocular surface stress has become even more pronounced due to decreased blink rate and greater tear evaporation [9]. These exposures can occur throughout a person's career and lead to an increased risk of DED symptoms, as well as clinically meaningful DED. Vitamin D deficiency has been a recent interest as a potential contributing factor in the pathogenesis of DED in recent years [10]. Vitamin D has significant anti-inflammatory and immunomodulatory activity to support Ocular Surface Integrity and Tear Film stability [11]. It is anti-inflammatory and inhibits the production of cytokines like interleukin-1, interleukin-6 and tumour necrosis factor alpha, yet also helps the epithelial barrier function and corneal and conjunctival wound healing.

The hypovitaminosis D correlates with decreased TBUT, decreased Schirmer test, increased tear hyperosmolarity and increased severity of dry eye symptoms [12]. Moreover, vitamin D supplementation has been proven to positively affect tear secretion, decrease inflammation of the ocular surface and improve tear film stability in patients with DED. Although there is increasing evidence of vitamin D deficiency being associated with DED, there is limited literature that directly focusses on the association of vitamin D deficiency with DED in industrial workers, a high-risk occupational group. The studies that are available have concentrated on general hospital populations as opposed to occupation-specific populations that are exposed to environmental and industrial hazards. Furthermore, information on the prevalence of DED and its association with serum vitamin D levels among industrial workers in Indian population is still limited. Hence, the present study aimed to analyze the prevalence and demographic pattern of DED in workers in the industrial setting and its association with serum vitamin D levels and other occupational risk factors.

Objectives of the Study

- To find out the prevalence of DED among the industrial workers at ESIC (Employees' State Insurance Corporation) Model Hospital.
- To assess the demographic characteristics of the population of industrial workers who suffer from DED.
- To determine the relationship between occupational risk factors and DED.
- To examine the correlation between serum 25(OH)D levels with DES severity.

Materials and Methods

Study Design: The present study was an observational cross-sectional hospital-based study to assess the prevalence of DED among industrial workers, and its association with vitamin D level in the serum.

The study highlighted the factors of demographic and occupational risk factors for DED and the association between clinical dry eye parameters and vitamin D deficiency.

Study Setting: The study was conducted in the Department of Ophthalmology of ESIC Model Hospital on the industrial patients attending OPD. The industrial workers were selected as the target population due to the higher exposure to the eye of occupational hazards like dust, smoke, heat, chemicals, long duration of work and exposure to digital screens, which are known as a cause of ocular surface disorders and tear film instability.

Study Duration: With the approval from the Institutional Ethics Committee, the study was conducted for 1 year from January 2022 to December 2022. All participants signed informed consent forms prior to participating in the study.

Sample Size: In total, 220 industrial workers who met the inclusion criteria were included. In the study period, patients from the ophthalmology outpatient department were consecutively selected.

Inclusion Criteria

- Industrial workers between 21-60 years old
- People who are willing to take part and who are able to give informed consent
- People who have symptoms of DED
- Individuals who are regularly exposed to industrial environments as workers

Exclusion Criteria

- Ocular surgery and/or trauma history
- Contact lens users
- Patients who have autoimmune conditions like Sjögren or rheumatoid arthritis.
- Patients with Ocular infections or active ocular inflammation.
- Patients using topical ocular medications affecting tear secretion
- Patients who have abnormalities of their eyelid or corneal disease that makes it more difficult to assess the tear film.

Data Collection: All participants were given a structured proforma to obtain a detailed clinical and demographic history. Data included age, sex, Body

Mass Index (BMI), smoking status, alcohol consumption, the nature of working exposure, computer use, sun exposure, working hours and working environment were gathered. Ocular symptoms such as burning sensation, redness, foreign body sensation, itching, dryness and visual discomfort were recorded.

Diagnostic Methods

The OSDI questionnaire was used to assess dry eye symptoms, being a validated instrument for scoring symptoms and determining the severity of this condition. The secretion of tears was determined by Schirmer test without topical anesthesia. The stability of the tear was measured by TBUT with fluorescein dye under slit lamp examination. Using standard lab methods, the serum 25(OH)D]concentration was used to estimate serum vitamin D level. The participants were divided into vitamin D sufficient group and vitamin D deficient group based on the serum level of vitamin D.

Statistical Analysis: All the collected data were then entered in Microsoft Excel and analysed by the use of SPSS software version 25.0. Data were summarized with respect to descriptive statistics, including mean, standard deviation, frequency and percentage. Association between categorical variables was tested in the case of the Chi-square test, and Pearson correlation analysis was used to test the relationship between serum vitamin D levels and parameters related to dry eye (TBUT and Schirmer test). The criterion for the statistical significance was $P<0.05$.

Results

Demographic Characteristics: In the present study, 220 industrial workers were included. Of these, the majority of the participants were male (n=164), with 56 females participants, male-to-female ratio about 3:1. The higher proportion of males in the industrial occupations covered by the ESIC workforce is reflected in the large number of male participants in this study.

Almost 70% of the study population (n=154) from the age group 31-40 years, while the age group 41-50 years had the next largest number (n=74). There were 42 subjects aged between 21 and 30 years and 24 subjects aged between 51 and 60 years. The industrial workers studied were regularly subjected to several workplace hazards such as long working hours, chemical fumes, high temperatures at work, visual display terminals, dust particles and other toxic environmental agents. Many workers were also using computers and smart phones for extended periods of time which led to reduction in blink rate and stress on the ocular surface.

Table 1: Demographic Characteristics of Study Population (n = 220)

Variable	Number of Patients (n)	Percentage (%)
Gender		
Male	164	74.5%
Female	56	25.5%
Age Distribution		
21–30 years	42	19.1%
31–40 years	80	36.4%
41–50 years	74	33.6%
51–60 years	24	10.9%

Prevalence of Dry Eye Disease: The prevalence of DED was assessed with the OSDI, Schirmer test, and TBUT.

In this study, 75 of the 282 subjects (34.0%) were determined to have DED, using the OSDI scoring system. Of these, 40 had mild DED, 21 had moderate DED and 14 had severe DED. The Schirmer test was used to assess DED and revealed 35 subjects (15.9%) with mild DED and 27 (10.9%) with severe tear deficiency. Of these 175 (79.5%) had tear film instability with 83 of those subjects having moderate TBUT abnormalities and 92 having severe abnormalities.

Table 2: Prevalence of DED Based on OSDI Score

OSDI Grade	Number of Patients (n)	Percentage (%)
Normal	145	65.9%
Mild	40	53.3%
Moderate	21	28.0%
Severe	14	18.6%
Total DED	75	34.0%

Table 3: Prevalence of DED Based on Schirmer Test

Schirmer Grade	Number of Patients (n)	Percentage (%)
Normal	185	84.0%
Mild	8	3.6%
Severe	27	12.2%
Total DED	35	15.9%

Table 4: Prevalence of DED Based on TBUT Grading

TBUT Grade	Number of Patients (n)	Percentage (%)
Normal	45	20.4%
Moderate	83	47.4%
Severe	92	52.5%
Total DED	175	79.5%

Occupational Risk Factors: Industrial workers had significantly high association with occupational and environmental exposures and the occurrence of DED. The workers who had visual display terminal exposure for longer duration, chemical exposure, smoke exposure, heat exposure, and stressful work conditions showed higher scores for OSTS and TFI.

The high workplace temperature was found to be a key factor, were exposure to noxious chemicals, long computer working hours, the use of smartphones and smoking. These exposures are likely to decrease blink rates and to have a negative impact on the integrity of conjunctival and corneal epithelial cells, thereby increasing workers' susceptibility to a dysfunction in the tear film and to DED.

Vitamin D Levels and DED Severity: The vitamin D serum level was assessed and four participants had adequate vitamin D levels (>30 ng/ml) while 29 participants had inadequate vitamin D levels (21–29 ng/ml). The majority of the study population (n=187) were vitamin D deficient (<20 ng/ml). Severe OSDI scores were noted in 14 participants with vitamin D deficiency, severe Schirmer abnormalities in 27 vitamin D-deficient participants and severe TBUT abnormalities in 92 vitamin D-deficient participants.

Table 5: Vitamin D Levels as per OSDI Score Grading

Serum Vitamin D Levels	Normal	Mild	Moderate	Severe	Total
>30 ng/ml	4	0	0	0	4
21–29 ng/ml	27	2	0	0	29
<20 ng/ml	114	37	22	14	187
Total	145	39	22	14	220

Table 6: Vitamin D Levels as per Schirmer Grading

Serum Vitamin D Levels	Normal	Moderate	Severe	Total
>30 ng/ml	4	0	0	4
21–29 ng/ml	29	0	0	29
<20 ng/ml	152	8	27	187
Total	185	8	27	220

Table 7: Vitamin D Levels as per TBUT Grading

Serum Vitamin D Levels	Normal	Moderate	Severe	Total
>30 ng/ml	4	0	0	4
21–29 ng/ml	27	2	0	29
<20 ng/ml	14	81	92	187
Total	45	83	92	220

Correlation Analysis: Pearson correlation analysis showed that serum vitamin D level was significantly and positively correlated with tear film parameters. Schirmer test reading of the right eye, Schirmer test reading of the left eye, TBUT of the right eye and TBUT of the left eye had positive correlations with Vitamin D level (r=0.497, r=0.481, r=0.387 and r=0.424, respectively).

All correlations were statistically significant with p-values <0.001. The results from this study suggest that there is a link between decreased levels of vitamin D and decreased tear secretion and tear film stability in industrial workers.

Table 8: Correlation between Vitamin D Levels and Dry Eye Parameters

Variables	Pearson Correlation (r)	p-value
Schirmer Test Reading – Right Eye	0.497	<0.001
Schirmer Test Reading – Left Eye	0.481	<0.001
TBUT – Right Eye	0.387	<0.001
TBUT – Left Eye	0.424	<0.001

Discussion

The present study showed that the prevalence of DED was high among industrial workers, which reflected the importance of the environmental factors and occupational exposure on the health of the ocular surface. The prevalence of DED in the current study was 34% and 79.5% of the participants had TBUT abnormalities based on OSDI assessment.

The results are similar to the reports of [13], who found a higher incidence of DED in stressed groups and long duration of visual strain. In the same manner, studies conducted by [14] showed that there was a strong correlation between dry eye symptoms and occupational exposure.

The findings of the present study were aligned with the studies conducted by [15], which also showed that there was a strong correlation between the dry eye symptoms and occupational exposure.

The industrial environment has constant exposure to high temperatures, smoke, dust particles, low humidity, and chemical irritants that all cause the eye's surface to be unstable and cause inflammation. Additionally, spending hours on a computer or on smart phone usage can result in less blinking and more evaporation of tears, which can make eyes drier. Other factors such as smoking and working hours also exacerbate the damage to the OS, promoting increased oxidative stress and inflammation. In the present study, workers who were exposed to these occupational hazards had significantly higher mean DCS and abnormal tear film parameters.

It also showed that, there was a strong correlation between vitamin D deficiency and the severity of DED. The serum vitamin D level was significantly lower in the participants with lower Schirmer and TBUT values. Vitamin D has an important anti-inflammatory and immunomodulatory role in suppressing inflammatory cytokines and promoting epithelial healing of the ocular surface. It also helps stabilize and maintain the integrity of the cornea's epithlial surface layer. Hence, vitamin D deficiency might be considered a risk factor for chronic ocular surface inflammatory disorders and tear dysfunction.

This study's results highlight the significance of routine workplace eye screening, eye protection in the workplace and vitamin D supplementation awareness among industrial workers. One of the strengths of the study was the focus on a high-risk industrial population and the combination of both subjective and objective diagnostic techniques used to assess the presence of DED. The study was restricted by its single center, cross sectional design, and limited generalizability to the wider population.

Conclusion

Industrial workers are particularly at risk for DED because of their work and environment. There was a significant association between vitamin D deficiency and DED severity and tear film instability. There is potential to lessen the impact of DED in workplaces through early detection and prevention, workplace eye protection and vitamin D supplementation.

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