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Prevalence of dry eye disease among indoor and outdoor workers and the impact on work productivity in the West Bank of Palestine in 2024: a cross-sectional study

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Abstract

Background Dry Eye Disease (DED) is a multifactorial ocular condition characterized by the disturbance of the tear film and interpalpebral ocular surface. It is characterized by ocular itchiness, grittiness, burning, and visual disturbances. Many risk factors were linked to DED, including occupational-related risk factors. This study aimed to investigate the prevalence and impact of DED on work productivity among outdoor and indoor workers in the West Bank of Palestine and the impact of DED on daily activities performance.

Methods A population-based descriptive cross-sectional study was conducted on male and female Palestinian workers aged 18 years or older, carried out between July to October 2024. Structured interview questionnaires using the Arabic version of the Ocular Surface Disease Index questionnaire (Arab-OSDI) and the Work Productivity and Activity Impairment questionnaire (WPAI) for participants who scored 13 or higher on OSDI.

Results A total of 464 participants were included, ages 18 or older. Males were 81.3% of the study population. 50% of the sample were indoor workers and 50% were outdoor workers. The prevalence of DED in Palestinian workers was 61.4%, which was higher among outdoor workers (64.7%) than indoor workers (58.2%), but this difference was not statistically significant ($p = 0.15$). The impact of DED on work productivity was reported in all severity levels ($p < 0.001$); participants with severe DED had a mean of 5.93 h, which is higher than the mean for moderate and mild DED patients (4.71 and 3.42 h), respectively. Similarly, the impact on the ability to perform daily activities was significant ($p < 0.001$), greatest among respondents with severe disease (5.86 h).

Conclusions Outdoor workers have been associated with DED more than in-office workers in the West Bank. Meanwhile, workers with DED report lower productivity and struggle with everyday tasks regardless of the severity level. This underlines the detrimental effects of the workplace on the ocular surface, which present a significant risk for the onset and exacerbation of dry eye symptoms.

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Keywords Dry eye disease, Outdoor workers, Indoor workers, Work productivity

Background

Dry Eye Disease (DED), or keratoconjunctivitis sicca, is a multifactorial ocular condition characterized by the disturbance of the tear film and interpalpebral ocular surface [1]. It is associated with tear film hyperosmolarity and neurosensory abnormalities, accompanied by inflammation and damage to the ocular surface, which further exacerbate its impact on patients' quality of life [2, 3]. The etiology of DED is complex, encompassing both environmental and physiological factors. Common causes include reduced tear production and excessive evaporation [4]. The nature of DED symptoms and their intensity vary widely among patients and often manifest as ocular itchiness, grittiness, burning, soreness, increased watery discharge, foreign body sensation, and visual disturbances, which can significantly impact daily activities and work productivity [5]. Diagnostic evaluation typically combines subjective symptom assessment with objective clinical tests. Tools such as the Ocular Surface Disease Index (OSDI) questionnaire are widely used to quantify symptom severity and impact on quality of life [6].

There is a wide spectrum of risk factors for DED, including female gender, increasing age, certain comorbid conditions (e.g., hypertension, diabetes, thyroid disease), sun exposure, smoking, wearing contact lenses, previous eye surgery, and dry environments or workplaces [7, 8]. Occupational settings play a pivotal role in DED risk, with outdoor workers demonstrating higher susceptibility due to prolonged exposure to dust and wind [9, 10]. These occupational differences underscore the need to consider workplace conditions in understanding and mitigating DED.

The prevalence of DED varies widely across geographic regions, largely due to differences in environmental factors, diagnostic criteria, and population demographics [11]. Universally, DED prevalence ranges from 5% to over 50%, with higher rates observed in Asian and arid regions due to harsher environmental conditions [12]. In Palestine, was 64% in a previous study conducted in 2017 and the association risk factors were old age and being female [13]. DED imposes a significant burden on individuals by reducing their quality of life and work productivity. The economic implications are profound, with direct costs associated with treatment and indirect costs such as reduced employment, work absences, decreased productivity, and a decline in the quality of life [14]. Also, DED's impact on mental health, including associations with anxiety and depression, further compounds its societal burden [15].

Therefore, in this study, the aim is to fill the research gap by exploring how DED affects the productivity of both outdoor and indoor workers in the West Bank, the influence on their daily activities, and find the prevalence of DED for them.

Methods

In this cross-sectional study which was conducted between July to October 2024, 464 participants were aged 18 years or older from different locations in the West Bank including taxi stations for transportation drivers situated in the cities centers in West Bank, the downtown areas of these cities where mobile vendors suited, and various companies and bank branches. Sample size calculated using the prevalence of DED among Palestinian adults 64.0% [13]. Therefore the required minimum sample size was determined to be 329 based on the equation: $samplesize = \frac{Z_{1-\alpha/2}{}^2 \, \mathrm{p}(1-\mathrm{p})}{d^2}$, which was calculated with a precision/absolute error (d) of 5% and a type 1 error of 5% ($p < 0.05$). But, we were able to increase the sample size to include 464 participants.

During the recruitment process using non-probability convenience sampling, where participants were selected relying on their availability and accessibility in the mentioned locations**,** these participants were divided into 232 outdoor workers and 232 indoor office workers. Theses participants were selected through their working time hours. Also, they had to comply with the following criteria: currently workers either full- or part-time, and had been working in their current job for at least 6 months. The exclusion criteria included contact lens wearers, who had an allergic conjunctivitis, ongoing uveitis, or anterior segment infection, who had undergone ocular surgery in the preceding 6 months, and those who used any of the following in the previous month: topical ocular medications rather than lubricants, such as antibiotics, antivirals, corticosteroids, NSAIDs, decongestants, mydriatics, cycloplegics, IOP-lowering drops, anti-glaucoma medications, or allergy drops, or systemic medications, such as antihistamines, decongestants, acne medications, hormone replacement therapy, or oral contraceptives.

For the registered participants, written informed consent was obtained from all subjects after providing a complete description of the study and sufficient opportunity to ask questions during face-to-face interviews. Then, they were asked about their demographic data, including age, gender, education level,

and smoking status, information about each participant's health history (previous ocular surgeries and ocular and non-ocular comorbid diseases), information about medication use (lubricant eye drops use, and systemic medications), and employment history (employment type, work regions, work experience, time spent at work, use of electronic devices, and time spent on them). After that, the Arabic-language version of the OSDI questionnaire was used to assess dry eye which is a well-established, validated, and reliable tool for DED [16, 17] contains 12 questions subdivided into three sections: 5 questions on ocular symptoms, 4 on vision-related function, and 3 on environmental triggers [18]. The OSDI questionnaire was administered to all participants and its reliability in this study was assessed using Cronbach's alpha and found to be 0.882.

After that, those who got a score of 13 or above (285 participants) were able to complete the Work Productivity and Activity Impairment Questionnaire: Specific Health Problem, version 2.0 (WPAI-SHP) which assesses the impact of DED on work productivity and performance of daily activities outside work. The WPAI has demonstrated good validity and reliability since it has been significantly related to general health perceptions and global measures of interference with regular activity [19]. The questionnaire also sent to four professions, two were ophthalmologist and two researchers from medical background to give their expert opinion. Then, a pilot study was done on 25 participants to ensure the validity and reliability of Arabic language version. The calculated Cronbach's alpha was 0.416. It includes 6 questions about the current employment status, the number of work hours missed because of DED during last week, the number of work hours missed for other reasons during last week, the number of hours actually worked during last week, the degree of DED that affected productivity while working during the last week, and the degree of DED that affected regular activities.

After that, work productivity indices of absenteeism, presenteeism (on-the-job effectiveness), and productivity impairment (combined absenteeism plus presenteeism) (for employed patients) and the non-work-related productivity index of activity impairment (for all patients) were generated from the WPAI questionnaire responses as follows (Q represents the question number):

- *Absenteeism* (percent of work time missed due to dry eye) = [Q2/(Q2 + Q4)]*100.
- *Presenteeism* (percent impairment of work performance due to dry eye) = (Q5/10)*100.
- *Productivity impairment* (percent of overall work productivity lost due to dry eye) = {[Q2/(Q2 + Q4)] + [1-([Q2/(Q2 + Q4)] * (Q5/10)]} * 100.
- *Activity impairment* (percent impairment of non-work-related activities due to dry eye) = (Q6/10)*100.

Then, the data were analyzed by SPSS v 22. Descriptive and inferential statistical tests were used according to the nature and distribution of the data. Bivariate model was done by the Chi-square test for analyzing categorical variables, Fisher test for small sample size, the Kruskal–Wallis test was chosen for continuous data that were skewed. And multivariate logistic regression for the statistically significant variables. The alpha level was set at $p \leq 0.05$.

Results

Table 1 summarizes the baseline demographic and clinical characteristics data of the 464 participants. 232 (50%) were outdoor workers, of whom 231 (99.6%) were males and 1 (0.4%) was female, while the remaining 232 (50%) were indoor office workers, 146 (63%) of them were males and 86 (37%) were females. The study sample covered several age groups, with the highest percentage of outdoor workers ($n = 111$, 47.8%) being aged 36 to 55 and nearly half of indoor workers ($n = 119$, 51.3%) aged 26 to 35 years. Most of the outdoor respondents were smokers ($n = 147$, 63.4%) compared with indoor respondents, ($n = 99$, 42.7%).

Also, the majority of indoor workers are university graduates (96.6%) whereas (12.5%) for outdoor workers. Of the study sample, secondary, middle, and primary school graduates documented 20.3%, 17.5%, and 7.7%, respectively. For non-ocular conditions, of all workers, 19.2% reported comorbid conditions, with 13.8% of indoor workers and 24.6% of outdoor workers having comorbid diseases. While regarding medication use, 18.5% of all participants reported medication use. For the use of lubricant eye drops, most of the participants (83.0%) reported no use, while 17.0% indicated their use.

In addition, for indoor workers regarding ocular comorbidities, the most frequent ocular disease was myopia, followed by astigmatism (4.3% and 2.2%, respectively). Compared with hyperopia (2.2%) for the outdoor workers see Table 1 (page 25).

Moreover, the prevalence of DED was higher in older individuals, who were aged above 35 years, compared to the younger age groups who were aged less than 35 years; this difference was significant ($p < 0.001$). The gender had no significant difference ($p = 0.53$), with females being more likely to experience DED (64.4%) compared to males (60.7%). In terms of education level, there was also a significant association ($p < 0.001$), with individuals with lower educational attainment, such as primary school (72.2%) or middle school (75.3%), having a higher prevalence of DED compared to those with secondary school (53.2%) and college or higher education (58.5%). Smoking

Table 1 Patients' demographic and clinical characteristics

	Outdoor Workers ($n=232$) (%)	Indoor Workers ($n=232$) (%)	Total ($N=464$) (%)
Age groups:			
18–25	27 (11.6%)	21 (9.0%)	48 (10.3%)
26–35	47 (20.3%)	119 (51.3%)	166 (35.8%)
36–55	111 (47.8%)	81 (35.0%)	192 (41.4%)
> 55	47 (20.3%)	11 (4.7%)	58 (12.5%)
Gender:			
Male	231 (99.6%)	146 (63.0%)	377 (81.3%)
Female	1 (0.4%)	86 (37.0%)	87 (18.7%)
Education level:			
Primary School	29 (12.5%)	7 (3.0%)	36 (7.7%)
Middle School	81 (35.0%)	0 (0%)	81 (17.5%)
Secondary School	93 (40.0%)	1 (0.4%)	94 (20.3%)
College and Higher	29 (12.5%)	224 (96.6%)	253 (54.5%)
Smoking/Shisha:			
No	85 (36.6%)	133 (57.3%)	218 (47.0%)
Yes	147 (63.4%)	99 (42.7%)	246 (53.0%)
Non-ocular comorbidities:			
No	175 (75.4%)	200 (86.2%)	375 (80.8%)
Yes	57 (24.6%)	32 (13.8%)	89 (19.2%)
Medication use:			
No	177 (76.3%)	201 (86.6%)	378 (81.5%)
Yes	55 (23.7%)	31 (13.4%)	86 (18.5%)
Ocular comorbidities:			
No comorbidity	224 (96.5%)	208 (89.7%)	432 (93.1%)
Myopia	2 (0.9%)	10 (4.3%)	12 (2.6%)
Hyperopia	5 (2.2%)	4 (1.7%)	9 (1.9%)
Astigmatism	0 (0%)	5 (2.2%)	5 (1.1%)
Myopia and Astigmatism	0 (0%)	4 (1.7%)	4 (0.9%)
Cataract	1 (0.4%)	1 (0.4%)	2 (0.4%)
Lubricant eye drops use:			
No	224 (96.6%)	161 (69.4%)	385 (83.0%)
Yes	8 (3.4%)	71 (30.6%)	79 (17.0%)
Previous diagnosis of DED:			
No	220 (95.0%)	153 (66.0%)	373 (80.4%)
Yes	12 (5.0%)	79 (34.0%)	91 (19.6%)

had no significant association with DED ($p=0.18$); it was associated with a slightly higher proportion of DED cases (64.2%) compared to non-smokers (58.3%).

Participants with non-ocular comorbidities showed a notably higher prevalence of DED (78.7%) compared to those without comorbidities (57.3%); this difference was significantly associated with DED ($p<0.001$). Similarly, individuals using medications also had a significant association with DED ($p<0.001$), which reported more DED (80.2%) compared to non-users (57.1%). Among ocular comorbidities, participants without any ocular issues reported a lower prevalence of DED than those with ocular comorbidities such as myopia, hyperopia, cataract, and astigmatism, while these comorbidities were also not significantly associated with DED ($p=0.60$). Whilst, Lubricant eye drop use was significantly associated with DED ($p<0.001$), with 79.7% of users reporting DED. Additionally, a previous diagnosis of DED was significantly linked to current DED ($p<0.001$), with 81.3% of previously diagnosed individuals reporting DED compared to 56.6% of those without prior diagnoses see Table 2 (page 26).

Table 2 Association of Dry Eye (diagnosed by OSDI) with study groups

	DED present		DED absent		*P*-value
	n	(%)	n	(%)	
Age groups:					**< 0.001**
18–25	16	33.3%	32	66.7%	
26–35	98	59.0%	68	41.0%	
36–55	132	68.8%	60	31.2%	
> 55	39	67.2%	19	32.8%	
Gender:					0.53
Male	229	60.7%	148	39.3%	
Female	56	64.4%	31	35.6%	
Education level:					**< 0.001**
Primary School	26	72.2%	10	27.8%	
Middle School	61	75.3%	20	24.7%	
Secondary School	50	53.2%	44	46.8%	
College and Higher	148	58.5%	105	41.5%	
Smoking/Shisha:					0.18
No	127	58.3%	91	41.7%	
Yes	158	64.2%	88	35.8%	
Non-ocular comorbidities:					**< 0.001**
No	215	57.3%	160	42.7%	
Yes	70	78.7%	19	21.3%	
Medication use:					**< 0.001**
No	216	57.1%	162	42.9%	
Yes	69	80.2%	17	19.8%	
Ocular comorbidities:					0.60
No ocular comorbidity	261	60.4%	171	39.6%	
Myopia	8	66.7%	4	33.3%	
Hyperopia	7	77.8%	2	22.2%	
Astigmatism	4	80.0%	1	20.0%	
Myopia and Astigmatism	3	75.0%	1	25.0%	
Cataract	2	100.0%	0	0.0%	
Lubricant eye drops use:					**< 0.001**
No	222	57.7%	163	42.3%	
Yes	63	79.7%	16	20.3%	
Previous diagnosis of DED:					**< 0.001**
No	211	56.6%	162	43.4%	
Yes	74	81.3%	17	18.7%	

The prevalence of DED in Palestinian workers was 61.4%, which was higher among outdoor workers (64.7%) compared to indoor workers (58.2%), but this difference was not statistically significant ($p = 0.15$). Among work regions, Nablus had the highest percentage of DED cases (66.2%), followed by Tulkarm (60.8%), while Jenin (51.5%) and Ramallah (55.6%) reported comparatively lower percentages ($p = 0.17$).

Work experience showed a significant relation with DED prevalence ($p = 0.05$); individuals with more than 10 years of experience had a higher prevalence of DED compared to those with less than 10 years. However, the number of days spent at work weekly did not show marked differences, with those working 5 days or fewer reporting 60.7% DED prevalence and those working more than 5 days reporting 62.1% ($p = 0.75$). Furthermore, time spent at work daily showed slight variations, with those working more than 10 h daily reporting a higher prevalence of DED (65.9%) compared to those working fewer than 8 h (61.0%) ($p = 0.65$).

Similarly, the prevalence of DED increased with daily electronic device usage, with 68.3% of those ($n = 84$) using devices for 2 h or less reporting DED, compared to 60.0% of those ($n = 129$) using devices for more than 6 h ($p = 0.16$). Among electronic devices, although the highest prevalence of DED was observed in individuals who did not use any electronic devices during the day

Table 3 Employment Factors and Presence of DED

	DED Present		DED Absent		*P*-value
	n	(%)	n	(%)	
Work type:					0.15
Outdoor Workers	150	64.7%	82	35.3%	
Indoor Workers	135	58.2%	97	41.8%	
Work region:					0.17
Nublus	129	66.2%	66	33.8%	
Jenin	34	51.5%	32	48.5%	
Tulkarm	107	60.8%	69	39.2%	
Ramallah	15	55.6%	12	44.4%	
Work experience (years):					0.05
< 5	49	55.7%	39	44.3%	
5–10	71	54.6%	59	45.4%	
11–15	41	63.1%	24	36.9%	
> 15	124	68.5%	57	31.5%	
Days spent at work weekly:					0.75
5 or less	128	60.7%	83	39.3%	
> 5	157	62.1%	96	37.9%	
Time spent at work daily (hours):					0.66
< 8	50	61.0%	32	39.0%	
8–10	181	60.3%	119	39.7%	
> 10	54	65.9%	28	34.1%	
Time spent on electronic devices daily (hours):					0.16
2 or less	84	68.3%	39	31.7%	
3–6	72	57.1%	54	42.9%	
> 6	129	60.0%	86	40.0%	
The electronic device used the most during the day:					
None	10	90.9%	1	9.1%	**0.04**
Smartphone	221	61.7%	137	38.3%	0.80
Laptop	32	58.2%	23	41.8%	0.59
Desktop computer	104	60.1%	69	39.9%	0.65
iPad	10	76.9%	3	23.1%	0.24
Television	64	79.0%	17	21.0%	**< 0.001**

(90.9%), the prevalence was lower among those who primarily used any electronic devices, such as smartphones, laptops, desktop computers, iPads, and televisions, during the day. While the strongest association with DED presence was noted among workers who don't use electronic devices and TV users ($p=0.04$) and ($p<0.001$), respectively see Table 3 (page 27).

A multivariate logistic regression model was conducted to identify the significant risk factors that are associated with symptomatic DED. The study noted that a worker's age was found to be correlated with their risk of developing dry eye illness; the older the worker, the higher the risk (OR = 1.188; 95% CI: 0.917, 1.54; $P=0.193$), even though this was not significant by multivariate analysis. Also, there was no significant association noted with non-ocular comorbidities (OR = 1.392; 95% CI: 0.2, 9.66; $P=0.738$), medication use (OR = 1.587; 95% CI: 0.223, 11.291; $P=0.645$), and lubricant eye drops use (OR = 1.821; 95% CI: 0.905, 3.667; $P=0.093$). On the other hand, workers who had a previous diagnosis of DED were noted to be 2.8 times more likely to develop DED compared to workers with no history of previous DED (OR = 2.815; 95% CI: 1.456, 5.442; $P=0.002$) see Table 4.

Table 4 Logistic regression analysis of risk factors associated with symptomatic DED

Risk factors	*P*-value	OR (95% CI)
Age groups	0.193	1.188 (0.917–1.54)
18–25		
26–35		
36–55		
> 55		
Education level:	0.217	0.838 (0.633–1.109)
Primary School		
Middle School		
Secondary School		
College and Higher		
Non-ocular comorbidities:	0.738	1.392 (0.2–9.66)
No		
Yes		
Medication use:	0.645	1.587 (0.223–11.291)
No		
Yes		
Lubricant eye drops use:	0.093	1.821 (0.905–3.667)
No		
Yes		
Previous diagnosis of DED:	**0.002**	2.815 (1.456–5.442)
No		
Yes		

DED severity was assessed by the OSDI questionnaire as follows: mild in 96 participants (33.7%), moderate in 63 participants (22.1%), and severe in 126 participants (44.2%). All these participants were either in full- or part-time employment at the time of the study.

The mean number of work hours missed per patient due to DED during the last week was significantly greater in severe DED patients (4.36 h) than in those with moderate (1.69 h) or mild (0.58 h) disease ($p<0.001$). In comparison, the mean of work hours missed for other reasons during the same period was 2.981 h, with the highest mean for mild DED patients (3.394 h), however, this was not statistically significant ($p=0.62$).

Meanwhile, the mean hours worked during the past week was 48.334 h, which was lower in moderate and severe DED patients (44.112 and 44.857 h, respectively). This was not statistically significant ($p=0.06$).

Additionally, the association regarding the impact of DED on work performance during the past week was significant ($p<0.001$), having a mean score of 3.97, with the highest impact on severe DED patients (5.93). Similarly, the mean impact of DED on non-work-related daily activities during the same period was 3.44, with the highest impact on severe DED patients (5.86), yielding a significant association ($p<0.001$) see Table 5.

Absenteeism due to DED was uncommon, but patients with severe DED reported missing more work time (2.09%) than patients with mild or moderate DED (0.89% and 0.28%), respectively. Similarly, impairment of work performance due to DED was interestingly higher among workers with severe disease (7.99%).

In addition, productivity impairment while at work was reported by all three severity groups, and patients with moderate (15.93%) and severe (20.4%) disease had greater reductions in productivity than (13.66%) with mild disease.

However, impairment in the ability to perform regular daily activities was observed among all three severity groups, which was significantly greater among patients with severe DED (14.56%) than those with moderate (9.84%) and mild (7.48%) disease. See Fig. 1.

Discussion

In this study, the prevalence of DED was 61.4%, which aligns closely with findings from a study conducted across 16 towns in the Northern West Bank in 2017, which reported a prevalence of 64.0% [13]. On the other hand, the prevalence varies considerably from a study done in Gaza in 2022 where the prevalence was 31.5% [20]. This discrepancy may be ascribed to differences in the populations studied.

This study also revealed a higher prevalence of DED among outdoor workers compared to indoor workers

Table 5 Work Productivity and Activity Impairment Questionnaire Item Outcomes, Categorized by OSDI

WPAI Questionnaire Items	OSDI Dry Eye Severity				*P*-value	Effect size
	Mild, $n=96$	Moderate, $n=63$	Severe, $n=126$	Overall, $N=285$		
Q1. Currently employed, **n (%)**	96 (100)	63 (100)	126 (100)	285 (100)		
Q2. Work hours missed due to dry eye during the past week, **mean (SD)**	0.58 (1.94)	1.69 (4.17)	4.36 (6.83)	1.17 (3.40)	**<0.001**	**0.28**
Q3. Work hours missed for other reasons during the past week, **mean (SD)**	3.39 (6.71)	2.06 (4.49)	2.71(4.48)	2.98 (6.03)	0.62	
Q4. Hours worked during the past week, **mean (SD)**	50.50 (17.82)	44.11(16.37)	44.86(19.67)	48.33 (17.74)	0.06	
Q5. Impact of dry eye on work performance during past week, **mean (SD)** score on a scale of 0 to 10	3.42 (2.41)	4.71 (2.77)	5.93 (1.98)	3.97 (2.60)	**<0.001**	**0.40**
Q6. Impact of dry eye on non–work-related daily activities during the past week, **mean (SD)** score on a scale of 0 to 10	2.97 (2.49)	3.90 (2.57)	5.86 (0.95)	3.44 (2.56)	**<0.001**	**0.40**

(64.7% and 58.2%, respectively). This can be explained by the increased exposure of outdoor workers to environmental irritants like dust, smoke, and sunlight. These findings are aligned with a Nigerian study, which reported a prevalence of 35.7% for outdoor street sweepers and 20.0% for indoor office sweepers, which was also measured by the OSDI questionnaire [9]. However, a UK study provided opposing results, suggesting that outdoor workers have a lower risk of symptomatic dry eyes, while occupations involving high screen use showed the highest prevalence. This was largely credited to the frequent use of contact lenses among these workers [21].

Numerous studies have investigated the relationship between DED and aging, revealing inconsistent findings. While some research has indicated a higher prevalence of DED among older individuals [13, 22], other studies have not shown this association [23]. In this study, a significant correlation ($p<0.001$) was reported between age and DED, with older adults being at a notably higher risk compared to younger individuals. This corresponds with findings from earlier research, which suggest that the elderly have a 75% higher risk of DED compared to young individuals [24].

Regarding gender, the evidence remains conflicting. Some studies have reported no significant association between DED and gender [23], while others have found a link [13, 20, 25]. Nevertheless, a strong link between feminine gender and DED was documented through previous studies, which could be attributed to the different hormone levels throughout female life that affect the lacrimal gland and ocular surface, potentially explaining the higher prevalence of DED in women in particular studies [13, 26]. However, in this study, no independent correlation between DED and gender was identified ($p=0.53$).

DED prevalence was higher in smokers, but the difference was not statistically significant ($p=0.18$), in agreement with other studies [13, 27], while other reports showed an association [25, 28–30]. This may be explained by exposure to tobacco smoke, which can impair ocular

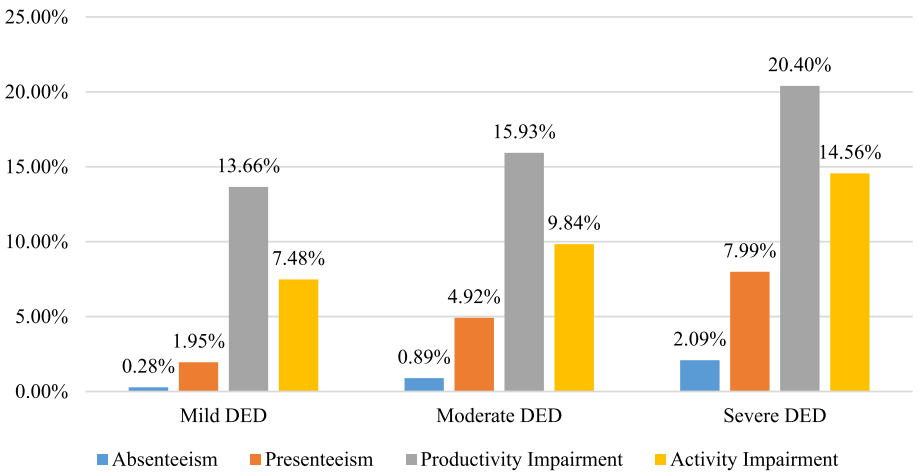

Fig. 1 Work Productivity and Activity Impairment questionnaire domain scores, categorized by OSDI ocular disability level

surface defense and retinal nerve fiber layer, along with impacting tear film secretion and stability [30].

Artificial tears are used to lubricate dry eyes and keep the outer surface of the eyes hydrated. Traditionally, they have been utilized as a first-line therapy to alleviate symptoms at every stage of DED treatment. Nevertheless, its primary purpose is to prevent the accumulation of symptoms rather than to alleviate them, as a recent study mentioned [31]. In the presented study, the use of lubricant eye drops was more common among those having DED ($p<0.001$) than those who did not have DED. That agreed with previous studies [20, 32].

In this study, no association between ocular diseases and DED ($p=0.60$), but a significant correlation was observed between systemic diseases and DED ($p<0.001$). This could be explained by the fact that 68.8% of the study participants who have DED are within the older age group (>35 years) and more likely to have systemic comorbidities. Paulsen et al. conducted comprehensive research on the link between Dry eye syndrome (DES) and systemic disorders and found that dry eyes can be caused by systemic disorders like allergies, arthritis, and thyroid disease [33]. While other meta-analysis studies found that hypertension and Diabetes Mellitus were associated with an increased risk of DED [26].

Dry eye syndrome onset and progression have been linked to several systemic drugs, such as anxiolytics, antidepressants, antihistamines, and antihypertensive medications [26, 34]. In support of this, the present study confirmed that intake of systemic medication was independently associated with DED ($p<0.001$). The present study also found a significant association between participants who had a previous diagnosis of DED and active DED ($p<0.001$).

For employment factors, the frequency of DED was higher (68.5%) among participants who had worked for more than 15 years. Despite this, the difference was marginally significant ($p=0.05$). However, another study finds no connection between DED severity and work experience [35].

Although not statistically significant ($p=0.66$), the prevalence of DED was highest among participants who spent more than 10 h at work daily (65.9%). Digital screen time is strongly linked to DED, as indicated by numerous studies [36, 37]. An increase in digital screen time of one hour per day was linked to 1.14 higher odds of developing dry eye illness [38]. The reason for this correlation may be that while performing tasks requiring a lot of visual processing, specifically activities with higher cognitive demands, the spontaneous blink reflex is suppressed. Consequently, low blink rate and partial blinking lead to unstable tear films and poor tear lipid layer integrity [34]. According to Wang et al., DED was independently linked to more hours spent in front of a digital screen each day [38]. Nevertheless, the current study found no correlation between DED and screen time on electronic devices ($p=0.16$). Moreover, the increasing use of smartphones, laptops, desktop computers, iPads, and televisions has led to an increase in the prevalence of DED. Interestingly, the current study has only found an independent relationship between using a television and not using any kind of device.

Although not being sight-threatening symptoms, as the dryness progresses or worsens, they become more troubling and burdensome for the sufferers [39], consistent with this study that found a considerable impact of DED on work productivity and non-job-related daily activities, Productivity loss was evident in all groups of dry eye severity, but it increased sharply as severity increased. Work productivity decreased by 13.66% for patients with mild DED, 15.93% for those with moderate DED, and 20.4% for those with severe DED. For non-work-related activities, impairment was increased similarly as severity increased. It has been demonstrated that DED affects job attendance more than absenteeism; only a small percentage of responders missed work because of their DED; patients with severe DED missed an average of 4 work hours each week.

The outcomes of this study are in alignment with previously published data regarding the effect of DED on work productivity and performance of non–work-related activities [14] in a previous study using the WAPI questionnaire in 158 patients attending clinics for relief of dry eye symptoms, indicating that dry eye resulted in a loss of 0.36% of work time and ~30% impairment of workplace performance (presenteeism), work productivity, and non–job-related activities. Presenteeism and productivity impairment scores showed a significant correlation with the OSDI total ($r=0.55$); the activity impairment score showed a stronger correlation with the OSDI total ($r=0.61$) [40].

The impairment to both employment and daily activities imposed by DED, as indicated in this study, contributes to the burden for patients who have been proven to have decreased quality of life and psychological stress due to their condition [12, 39, 41].

There are several limitations of this study that might have affected its results: the sample lacked demographic variety, with few participants under 25 and over 55. In addition, the majority of responders were males, especially in outdoor workers, which limited the results' applicability to larger populations. Also, working conditions couldn't be standardized optimally for outdoor workers, especially for the amount of sunlight and dust exposure between outdoor workers, which may have biased the results for the prevalence of DED.

Furthermore, the accuracy of DED diagnoses may have been compromised by the OSDI questionnaire's dependence on self-reported symptoms rather than objective diagnostic methods like schirmer's test, non-invasive tear break-up time (TBUT), or tear film osmolarity testing.

Moreover, the study introduced a Potential bias such as the selection bias as the data collected through convenient sampling, Recall bias as we asked about the ocular surgeries before 6 months.

Finally, these limitations should be considered when interpreting the results and in designing future studies to ensure more representative and accurate data with objective diagnostic measures and a more diverse sample to enhance the understanding of DED in different occupational groups.

Conclusion

To sum up, the prevalence of DED among worker categories in a previously unexamined Palestinian population was found to be 61.4%, which is quite significant. Moreover, considering the diverse environmental working conditions, outdoor workers are more prone to experience dry eye symptoms compared to indoor workers. Additionally, employees with DED report reduced productivity and face difficulties with daily activities, regardless of the severity level. These results highlight the critical need for integrating regular eye screening programs in high risk occupations associated with DED and implementing effective strategies in the workplace, such as utilizing eye shields that would be protective against environmental irritants and pollutants, as well as enhancing indoor working conditions (frequent breaks, humidifiers use), which could substantially lower the risk and progression of DED. Efforts should be directed towards enhancing societal awareness about DED to reduce its modifiable risk factors.

Abbreviations

DED	Dry Eye Disease
OSDI	The Ocular Surface Disease Index questionnaire
WPAI	The Work Productivity and Activity Impairment questionnaire

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Authors' contributions

SA, SS, QS, JQ, HA, SA Conceptualization, Data Collection, and writing. JQ, SA, SS, QS analysis and interpretation of data HA. SA, SS, QS, JQ, SA drafted the work and revised it All Authors approved the submitted version, agreed both to be personally accountable for the contributions and integrity of any part of the work.

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Data availability

The data that support the findings of this study are not openly available due to reasons of sensitivity and are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate

Before collecting data, institutional review board approval was obtained from An-Najah National University (Ref: Med. Dec. 2023/91), and permissions were granted by companies' managers before we started this study. We obtained informed consent from the participants, ensuring their privacy and confidentiality, by choosing a quiet and secluded area away from others. We needed to ensure sufficient physical distance to prevent easy overhearing, speak softly, and avoid sensitive questions in public. We used a cover sheet to help shield responses, and we were mindful of participants' comfort through attentive body language during the interview. And participants' data was to be only accessible to researchers. Participation in our study was entirely voluntary, and participants had the right to withdraw from the study at any time.
This study was conducted in accordance with the ethical principle of the declearation of Helsinki.

Consent for publication

Not applicable in this section.

Competing interests

The authors declare no competing interests.

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