Original Research

The relationship between occupation and dry eye

Shehnaz Bazeera, Nomdo Jansonius, Harold Snieder, Christopher Hammond, Jelle Vehof

ABSTRACT

Introduction: Environmental factors play an important aetiologial role in dry eye. This cross-sectional study investigated the relationship between types of occupation and symptomatic dry eye.

Methods: 40,501 employed people working ≥8 h a week were included from the population-based Lifelines cohort in the Netherlands. Logistic regression was used to determine the association between symptomatic dry eye (assessed by the WHS questionnaire) and occupation (using the ISCO-08 classification system).

Results: After correction for age and sex, the professionals (e.g. legal, health, and business and administration professionals) (OR=1.14, 95%CI=1.08–1.19, P < 0.001) and clerical support workers (OR=1.14, 95%CI=1.07–1.22, P < 0.001) had the highest risk of dry eye of all 10 major occupation groups. Skilled agricultural workers (OR=0.57, 95%CI=0.49–0.67, P < 0.001) and elementary occupations (OR=0.77, 95%CI=0.69–0.85, P < 0.001), such as cleaners and carers, carried the lowest risk of dry eye. After additional correction for 45 dry eye associated comorbidities, professionals and clerical support workers showed no increased risk anymore, while craft and related trades workers, e.g. building workers and metal and machinery workers, showed the highest risk of dry eye (OR=1.12, 95%CI=1.02–1.24, P=0.01).

Conclusions: This study underlines the importance of asking about type of occupation in dry eye patients. Screening for symptomatic dry eye in high risk occupations such as in building workers and in indoor occupations with high screen use is relevant from an occupational health and work productivity perspective. The lower risk of dry eye in outdoor and active occupation is intriguing and justifies future studies to investigate potential protective and treatment effects.

1. Introduction

Dry eye disease is a highly prevalent multifactorial disease [1,2] that seriously affects quality of life and work productivity [3–8]. Population-based studies show a prevalence of symptomatic dry eye ranging from 6 to 52%, depending on the definition used and population investigated [2]. A classic twin study by our group has shown that both genetic and environmental factors are important in dry eye disease, with environmental factors estimated to be responsible for most of the variation of dry eye symptoms in the population, up to 70% [9]. Although genes underlying dry eye disease have not yet been identified, several studies have linked specific environmental factors to dry eye disease, such as air pollution [10], visual display terminal (VDT) use [11–13], low humidity [14], and air conditioning [2,14]. Given these findings, the type of occupation could play an important role in dry eye disease. A few cross-sectional studies have indeed suggested that occupation is a contributing factor to dry eye symptomatology [10,11,15–17] with an increased prevalence of dry eye in indoor occupations and in VDT users. However, to date, there has not been any large population-based study that has investigated the relationship between all types of occupation and dry eye disease, using a hypothesis-free approach, while correcting for dry eye associated comorbidities and traits. Therefore, this study investigated this relationship in the large population-based Lifelines cohort in the Netherlands.

2. Material and methods

2.1. Lifelines cohort and participants

Lifelines is a multi-disciplinary prospective population-based cohort study examining the health and health-related behaviours of 167,729 persons living in the north of The Netherlands. It employs a broad range of investigative procedures in assessing the biomedical, socio-demographic, behavioural, physical, and psychological factors which...
contribute to the health and disease of the general population, with a special focus on multi-morbidity and complex genetics [18]. Participants, almost exclusively of European ancestry, were included via general practitioners or self-enrolment between 2006 and 2013 and will be followed for at least 30 years. The cohort is described in detail elsewhere [19]. The study protocol was approved by the medical ethics committee of the University Medical Center Groningen, was carried out in accordance to the Declaration of Helsinki, and all participants provided written informed consent. For the purpose of this study we assessed the first 79,866 participants (age range 19–94 years, 59% female) during their first follow-up visit between 2014 and 2017.

2.2. Assessment of symptomatic dry eye

No gold standard for a diagnosis of dry eye disease exists. In this study dry eye disease was assessed with the Women's Health Study (WHS) dry eye questionnaire. This short questionnaire has been validated against a standardized clinical exam [20] and showed similar sensitivity and specificity as a 16-item instrument [21]. It is the most widely used dry eye questionnaire in population-based studies [2]. For this study we used its two questions about current symptoms of dry eye: “How often do your eyes feel dry (not wet enough)?” and “How often do your eyes feel irritated?” (both with possible answers: 0 = never, 1 = sometimes, 2 = often, or 3 = constantly). As a primary outcome variable, we defined symptomatic dry eye as a total score of 2 or higher on these two questions (i.e., either both dryness and irritation symptoms ‘sometimes’ or at least ‘often’ symptoms of dryness and/or irritation).

2.3. Assessment of occupation

All participants completed a questionnaire at baseline (2006–2010) including multiple questions about the name and exact activities of the occupation including leadership tasks. Also the total hours worked per week was asked, both at baseline and at follow-up, concurrent with dry eye symptom assessment. The ISCO-08 (International Standard Classification of Occupations 2008) system [22] was used to code occupations. 436 unit groups form the most detailed occupation level of this classification structure. These unit groups are aggregated into 130 minor groups, 43 sub-major groups and 10 major groups. The key to this aggregation process is the similarity in terms of the skill level and skill specialization needed for each occupation. The ISCO system allows the creation of detailed comparable data across different countries as well as summary information for only 10 groups at the highest level of aggregation [22]. An example of this classification system would be specialist medical practitioners (grouped under unit group), medical doctors (grouped under minor groups), health professionals (grouped under sub-major group) and professionals (grouped under major group). The coding was performed with an automated process developed by the University of Warwick (CASCOT) [23]. For each participant a Cascot-generated probability score (0–100) of a correct ISCO-08 coding is given. We excluded participants where this probability score was low (i.e. 40 or lower), to ensure an overall 91% rate of correct coding for the major groups, and 88% for the sub-major groups, estimated from a random subsample of 5000 participants in Lifelines that were manually checked for correctness of ISCO-08 coding. Unemployed participants were excluded from further analyses, as were employed participants working less than 8 h per week at the time of dry eye assessment, to ensure sufficient exposure.

2.4. Statistics

Descriptive statistics were used to describe the characteristics and crude prevalence of symptomatic dry eye of the study population, stratified by major occupation group. Logistic regression, corrected for age and sex only, was used to assess the association with symptomatic dry eye for every major occupation group. The reference group for each association were all working people included in this study with a different occupation than the one investigated. Similarly, sub-major occupation groups were also analysed for an association with dry eye. Only sub-major groups with at least 160 participants were included, to ensure 80% power to detect an odds ratio of 1.6 with an alpha of 0.05. Additionally, the same logistic regression was performed for the major groups, with in addition to age and sex, correction for BMI, contact lens use and 45 comorbidities that were independently associated with symptomatic dry eye. These 45 dry eye associated comorbidities were macular degeneration, glaucoma or ocular hypertension, allergic conjunctivitis, Bell's palsy, keratoconus, eye surgery (any), laser refractive surgery, irritable bowel syndrome, fibromyalgia, costochondral junction syndrome, osteoarthritis, intervertebral disc herniation, repetitive strain injury, back pain, migraine, rheumatoid arthritis, Sjögren's syndrome, lichen planus, sarcoid, psoriasis, Graves' disease, eating disorder, ADHD, panic disorder, chronic fatigue syndrome, depression, 'burnout', asthma, hay fever, any allergy, acne, stomach ulcer, COPD, anaemia, osteoporosis, vitamin B12 deficiency, obstructive sleep apnoea syndrome, hypotension, atherosclerosis, arrhythmia, liver cirrhosis, gallstones, chronic cystitis, continent, and spasticity. All analyses were performed with IBM SPSS Statistics 23.0.

3. Results

In total 79,866 participants were screened for type of occupation and current working hours and symptoms of dry eye; 51,386 participants were employed and worked at least 8 h a week. Of these participants, 10,885 were excluded because the likelihood of correct coding to the exact ISCO-08 occupation group was low. So, a total of 40,501 individuals working at least 8 h a week were included in this study (mean age 46.4 years, s.d.9.6, 59.6% female). Table 1 describes the characteristics of the final study population stratified by major occupation groups, including unadjusted prevalence of symptomatic dry eye and corresponding adjusted odds ratios. The professionals, the technicians and associate professionals and the service and sales workers formed the biggest major occupational groups. Symptomatic dry eye was present in 29.8% of the total study population, with women (35.3%) having a higher prevalence than men (22.4%).

Fig. 1 graphically depicts the results of the association between major groups of occupation and symptomatic dry eye, corrected for age and sex only. Of the 10 major occupation groups, professionals (OR = 1.14, 95%CI = 1.08–1.19, P < 0.001) and clerical support workers (OR = 1.14, 95%CI = 1.07–1.22, P < 0.001) were associated with the highest risk of dry eye. Skilled agricultural workers (OR = 0.57, 95%CI = 0.49–0.67, P < 0.001) showed the lowest risk of dry eye, while elementary occupations (OR = 0.77, 95%CI = 0.69–0.85, P < 0.001), plant and machine operators and assemblers (OR = 0.80, 95%CI = 0.70–0.92, P = 0.001), and service and sales workers (OR = 0.88, 95%CI = 0.83–0.93, P < 0.001) were also associated with lower risk of dry eye disease.

Fig. 2 shows the association between sub-major groups of occupations and their association with dry eye disease, corrected for age and sex only. Of the professionals, occupations that were most associated with dry eye disease were legal, social and cultural professionals, and business and administration professionals, while teaching professionals showed no increased risk of dry eye. Of the clerical support workers, customer service clerks were most associated with dry eye disease. Of the elementary occupations, cleaners and helpers were particularly associated with less dry eye. The large majority of the skilled agricultural, forestry and fishery workers fell into the market-oriented skilled agricultural worker sub-major group (OR = 0.57, 95%CI = 0.48–0.67), so Fig. 2 gives no additional within-group information. While examining the different unit groups in this specific occupational sub-major group, we found no large differences in risks between the different occupations, with gardeners, horticultural and nursery growers (OR = 0.55, 95%CI = 0.40–0.76), field crop and...
Table 1
Characteristics of major occupation groups and their association with symptomatic dry eye.

<table>
<thead>
<tr>
<th>ISCO Major Occupation Group</th>
<th>n (% of total group)</th>
<th>Female (%)</th>
<th>Age, years (mean (sd))</th>
<th>Body mass index (kg/m2) (mean (sd))</th>
<th>Contact lens use (%)</th>
<th>Number of dry eye associated comorbidities(^a) (mean)</th>
<th>Any eye disorder (%)</th>
<th>Any psychiatric disorder (%)</th>
<th>Any pain disorder (%)</th>
<th>Any autoimmune disorder (%)</th>
<th>Any atopic disorder (%)</th>
<th>Any other dry eye associated disorder (%)</th>
<th>Symptomatic dry eye (%)</th>
<th>Adjusted OR for dry eye (95% CI) (corrected for age and sex only)</th>
<th>Adjusted OR for dry eye (95% CI) (corrected for age, sex, BMI, contact lens use and 45 dry eye associated comorbidities)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Armed forces occupations</td>
<td>52 (0.1%)</td>
<td>13.5%</td>
<td>39.9 (9.0)</td>
<td>27.3 (3.7)</td>
<td>23.1%</td>
<td>1.4</td>
<td>1.9%</td>
<td>13.5%</td>
<td>26.9%</td>
<td>5.8%</td>
<td>38.5%</td>
<td>17.3%</td>
<td>25.0%</td>
<td>1.04 (0.55–1.96)</td>
<td>1.01 (0.51–1.97)</td>
</tr>
<tr>
<td>Managers</td>
<td>1250 (3.1%)</td>
<td>36.9%</td>
<td>49.0 (8.3)</td>
<td>26.0 (3.8)</td>
<td>15.0%</td>
<td>2.0</td>
<td>9.7%</td>
<td>17.0%</td>
<td>37.6%</td>
<td>6.0%</td>
<td>49.0%</td>
<td>27.8%</td>
<td>28.6%</td>
<td>1.08 (0.96–1.23)</td>
<td>1.07 (0.94–1.22)</td>
</tr>
<tr>
<td>Professionals</td>
<td>10,356 (25.6%)</td>
<td>65.0%</td>
<td>46.0 (9.2)</td>
<td>25.7 (4.1)</td>
<td>17.5%</td>
<td>2.3</td>
<td>7.9%</td>
<td>24.4%</td>
<td>42.4%</td>
<td>5.8%</td>
<td>51.0%</td>
<td>37.7%</td>
<td>31.6%</td>
<td>1.14 (1.08–1.19)</td>
<td>1.02 (0.96–1.07)</td>
</tr>
<tr>
<td>Technicians and associate professionals</td>
<td>8144 (20.1%)</td>
<td>60.0%</td>
<td>46.0 (9.2)</td>
<td>25.7 (4.1)</td>
<td>17.5%</td>
<td>2.3</td>
<td>7.9%</td>
<td>24.4%</td>
<td>42.4%</td>
<td>5.8%</td>
<td>51.0%</td>
<td>37.7%</td>
<td>31.6%</td>
<td>1.07 (1.02–1.13)</td>
<td>1.02 (0.96–1.08)</td>
</tr>
<tr>
<td>Clerical support workers</td>
<td>4668 (11.5%)</td>
<td>72.6%</td>
<td>46.6 (8.9)</td>
<td>25.9 (4.3)</td>
<td>19.3%</td>
<td>2.4</td>
<td>8.4%</td>
<td>26.3%</td>
<td>45.0%</td>
<td>5.9%</td>
<td>50.3%</td>
<td>40.0%</td>
<td>33.9%</td>
<td>1.14 (1.07–1.22)</td>
<td>1.06 (0.99–1.14)</td>
</tr>
<tr>
<td>Service and sales workers</td>
<td>8520 (21.0%)</td>
<td>81.1%</td>
<td>45.7 (10.5)</td>
<td>26.1 (4.4)</td>
<td>12.6%</td>
<td>2.4</td>
<td>7.5%</td>
<td>23.9%</td>
<td>46.3%</td>
<td>5.6%</td>
<td>51.9%</td>
<td>41.1%</td>
<td>30.5%</td>
<td>0.88 (0.83–0.93)</td>
<td>0.97 (0.92–1.03)</td>
</tr>
<tr>
<td>Skilled agricultural, forestry and fishery workers</td>
<td>1127 (2.8%)</td>
<td>18.0%</td>
<td>48.6 (9.6)</td>
<td>25.0 (3.6)</td>
<td>5.1%</td>
<td>1.6</td>
<td>6.1%</td>
<td>13.4%</td>
<td>33.6%</td>
<td>5.3%</td>
<td>39.5%</td>
<td>23.2%</td>
<td>16.2%</td>
<td>0.57 (0.49–0.67)</td>
<td>0.70 (0.59–0.83)</td>
</tr>
<tr>
<td>Craft and related trades workers</td>
<td>3029 (7.5%)</td>
<td>8.9%</td>
<td>46.9 (9.2)</td>
<td>26.6 (3.8)</td>
<td>7.2%</td>
<td>1.7</td>
<td>7.1%</td>
<td>15.9%</td>
<td>33.1%</td>
<td>5.7%</td>
<td>42.9%</td>
<td>23.8%</td>
<td>23.1%</td>
<td>0.97 (0.89–1.07)</td>
<td>1.12 (1.02–1.24)</td>
</tr>
<tr>
<td>Plant and machine operators, and assemblers</td>
<td>1348 (3.3%)</td>
<td>15.4%</td>
<td>48.1 (9.5)</td>
<td>27.4 (4.1)</td>
<td>6.3%</td>
<td>1.9</td>
<td>8.2%</td>
<td>16.8%</td>
<td>37.4%</td>
<td>6.9%</td>
<td>43.2%</td>
<td>25.0%</td>
<td>20.7%</td>
<td>0.80 (0.70–0.92)</td>
<td>0.90 (0.78–1.04)</td>
</tr>
<tr>
<td>Elementary occupations</td>
<td>2007 (5.0%)</td>
<td>70.4%</td>
<td>46.2 (10.8)</td>
<td>26.5 (4.7)</td>
<td>9.8%</td>
<td>2.3</td>
<td>7.8%</td>
<td>22.9%</td>
<td>45.6%</td>
<td>5.8%</td>
<td>50.1%</td>
<td>38.5%</td>
<td>26.1%</td>
<td>0.77 (0.69–0.85)</td>
<td>0.88 (0.79–0.97)</td>
</tr>
<tr>
<td>Total group</td>
<td>40,501 (100%)</td>
<td>59.6%</td>
<td>46.4 (9.6)</td>
<td>25.9 (4.2)</td>
<td>15.3%</td>
<td>2.2</td>
<td>8.1%</td>
<td>22.7%</td>
<td>41.7%</td>
<td>5.6%</td>
<td>49.8%</td>
<td>35.8%</td>
<td>29.8%</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Only individuals who worked at least 8 h a week were included. ISCO = International Standard Classification of Occupations.

\(^a\) The 45 dry eye associated comorbidities were grouped in the following categories: eye disorders (macular degeneration, glaucoma or ocular hypertension, allergic conjunctivitis, Bell’s palsy, keratoconjunctivitis (any), laser refractive surgery), pain disorders (irritable bowel syndrome, fibromyalgia, costochondral junction syndrome, osteoarthritis, intervertebral disc herniation, repetitive strain injury, back pain, migraine), autoimmune disorders (rheumatoid arthritis, Sjögren’s syndrome, lichen planus, sarcoid, psoriasis, Graves’ disease), psychiatric disorders (eating disorder, ADHD, panic disorder, chronic fatigue syndrome, depression, ‘burnout’), atopic disorders (asthma, hay fever, any allergy), and other disorders (acne, stomach ulcer, COPD, anaemia, osteoporosis, vitamin B12 deficiency, obstructive sleep apnoea syndrome, hypotension, atherosclerosis, arrhythmia, liver cirrhosis, gallstones, chronic cystitis, incontinence, spasticity) [24].
vegetable growers (OR = 0.73, 95%CI = 0.48–1.12), livestock and dairy producers (OR = 0.56, 95%CI = 0.45–0.70), and poultry producers (OR = 0.73, 95%CI = 0.36–1.48) all showing similar reduced odds of dry eye.

Fig. 3 shows the associations between major groups of occupation and symptomatic dry eye, corrected for BMI, contact lens use, and 45 comorbidities associated with dry eye, in addition to age and sex. These results show that the increased risk of dry eye in professionals and clerical support workers has become less apparent. On the other hand, the craft and related trades workers were significantly associated with more dry eye after correction for these comorbidities. Within the craft and related trades workers occupation groups, building and related trades workers (OR = 1.20, 95%CI = 1.03–1.38, P = 0.02) and metal, machinery and related trades workers (OR = 1.20, 95%CI = 1.01–1.41, P = 0.04) were the two sub-major groups that were associated with increased risk of dry eye, while other sub-major groups such as handicraft and printing workers (OR = 0.96, 95%CI = 0.66–1.39, P = 0.82), electrical and electronic trades workers (OR = 0.96, 95%CI = 0.72–1.28, P = 0.78), and food processing, wood working and garment workers (OR = 0.95, 95%CI = 0.76–1.19, P = 0.66) showed no increased risk of dry eye. Interestingly, the protective effect of the skilled agricultural workers on dry eye disease still remains after correction for comorbidities, as does the mildly protective effect of elementary occupations.

4. Discussion

This large population-based study showed that people with indoor and sedentary occupations have a higher prevalence of dry eye disease, although this was largely mediated via dry eye associated comorbidities and traits that were more common in these occupations. After correction for dry eye associated comorbidities and traits, craft and related trades workers showed the highest risk of dry eye. This study also found a strong protective effect of most outdoor and
physically active occupations on dry eye disease, even after correction for other dry eye associated comorbidities and traits.

Of all occupations, the highest prevalence of dry eye was found in the clerical support workers and professionals. These occupations are associated with a relatively high use of visual display terminals (VDTs) and are mostly desk-bound, sedentary occupations. The regular use of VDTs has been associated with increased incidence of eye-strain and dry eyes in several studies [10,11]. Their use has been associated with reduced spontaneous blinking and subsequent break-up of the tear film [17]. Additionally, the relatively high presence of air conditioning in work environments of these occupations may contribute to increased break-up of the tear film and symptomatic dry eye [2,10,24], as do other climatic factors such as high room temperatures and low humidity [10]. However, when these associations were adjusted for the presence of dry eye associated comorbidities and traits, there remained only a slight increased risk of dry eye for these occupations, at borderline or no significance (Fig. 3). Professionals showed high rates of contact lens use (Table 1), an important risk factor of dry eye [1,2]. After investigation of the effect of covariates on the relation between professionals and dry eye, it was indeed contact lens use that acted as the most important confounder. After additionally adjusting for this trait only, the strong association between professionals and symptomatic dry eye completely disappeared (OR = 1.03, 95%CI = 0.98–1.09). Similar results were found for clerical support workers, where dry eye associated comorbidities also acted as moderate confounders. These findings emphasize the importance of taking into account other comorbidities, and most importantly contact lens use, when investigating environmental factors in cross-sectional studies; the higher prevalence of dry eye in certain occupations may not be purely environment driven, but a result of the characteristics of the associated employee.

After correction for dry eye associated comorbidities and traits, the craft workers and more specifically the building workers and metal and machinery workers showed the highest risk of symptomatic dry eye. This might not come as a surprise, as these occupations are associated with many hazards and health risks, including increased mortality [25]. This study showed that these workers were mostly male (91.1%) with few dry eye associated comorbidities and low contact lens use (see Table 1), yet had a relatively high prevalence of dry eye. Their work is characterized by a high exposure to dust, chemicals and toxins, and climatic influences [25,26], which could all be mechanisms leading to dry eye symptoms. Numerous studies have similarly shown an increased risk of dermatitis and asthma in these workers [27].

Interestingly, we found outdoor occupations to be strongly protective for dry eye, also when corrected for other comorbidities. In particular, skilled agricultural, forestry and fishery workers had a very low risk of dry eye. Elementary workers and to a lesser extent plant and machine operators, and assemblers, also showed a lower risk of dry eye. In addition to the relative absence of detrimental indoor climatic factors and lower VDT use in these occupations, it is also important to note that these occupations are predominantly active occupations.

Global public health organizations are increasingly warning about the health risks of physical inactivity, as numerous studies have shown an associated increased risk of many adverse health conditions such as coronary heart disease, cancer and diabetes [28–31]. A few studies that investigated office workers have also linked physical inactivity and sedentary behaviour to increased risk of dry eye [31,32]. Our study extends these findings, and clearly shows a link between active occupations, such as agricultural workers, personal service workers, cleaners and helpers, and lower levels of symptomatic dry eye, even after correction for dry eye associated comorbidities and traits. A proposed mechanism is that physical inactivity and sedentary behaviour lead to increased systemic inflammation via oxidative stress, including ocular surface inflammation and reduced mucin expression with subsequent increased tear film break up [32]. Another mechanism is that exercise and physical activity can alter pain perception and reduce pain symptoms [33].

The only other studies that have looked at occupational groups and dry eye were performed in the population-based cohort of the KNHANES V (Korean National Health and Nutrition Examination Survey V) [15,16]. Lee et al. [15] looked at occupational characteristics and the association with dry eye symptoms in a cross-sectional study of 6023 employed participants. Five grouped occupational categories were individually compared to green-collar workers (workers who are employed in agriculture, fishery or forestry). After correction for demographic and health behavioural factors, skilled blue-collar workers such as crafts persons, plant and machine operators and assemblers (OR = 1.48, 95%CI = 1.05–2.10), and ordinary white collar workers such as technicians and associate professionals (OR = 1.70, 95%CI = 1.18–2.45)) were found to have significantly increased odds of dry eye compared to these green collar workers. Although the study was not powered sufficiently to look at major groups separately and did not correct for dry eye associated comorbidities, it is interesting to note that the lowest prevalence of dry eye symptoms was also found in the group of agricultural, fishery and forestry workers. Similarly, Roh et al. [16] compared indoor versus outdoor occupations in this same cohort but with a larger sample size (n = 17,364), and found indoor occupations to be associated with a significant 1.3 times increased risk of dry eye compared to outdoor jobs, after correction for a set of systemic comorbidities, not specific for dry eye. Our results are broadly in line with these findings, but also show that it is important to correct for dry eye associated comorbidities and traits, which decreased the apparent high risk of dry eye of these indoor jobs substantially.

As for many other diseases, the disease burden of dry eye consists of decreased quality of life, direct costs such as for medical treatment, and indirect costs such as absence from work (absenteeism) and impaired work productivity (presenteeism). Studies have shown that dry eye is associated with serious loss of work productivity, and that this presenteeism is the most important indirect cost in dry eye [8,34,35]. Dry eye patients, on average, only take few days off work per year because of their dry eye, while dry eye symptoms are present on the far majority of working days, leading to serious loss of work productivity.
study by Patel et al. showed that the higher the score on a dry eye symptom questionnaire, the greater the loss of work productivity [36]. Similarly Nichols et al. showed a strong correlation between pre-senteemis and severity of dry eye symptoms, but interestingly this relationship was not found for severity of dry eye signs [35]. Yamada et al. showed that the medical costs for the treatment of dry eye outweigh the loss of work productivity [37]. Thus, from an occupational health and safety perspective, but also from a work productivity perspective, screening for symptomatic dry eye in high-risk occupations, such as in professionals and clerical support workers, might be very useful. Necessary ergonomic measures can then be taken if needed. In office environments strategies such as humidifiers [14,38] and screen-protectors for VDTs [39,40] may lower symptomatic dry eye. In building workers and metal and machinery workers appropriate eye-wear might prevent dry eye.

This study has some limitations. Firstly, it is a cross-sectional study, so we cannot imply causality between occupation and dry eye disease. To better understand the direction and strength of association, we have corrected for dry eye associated comorbidities and traits, but this approach still does not guarantee detection of a true causative association, because other confounding factors might have been missed, such as the use of digital devices outside employment, medication use (e.g. antihistamines, antianxiety agents) and other less prevalent comorbidities such as hematopoietic stem cell transplantation. On the other hand, it is also possible that adjustment results in over-correction, as we cannot disentangle the relationships between choice of occupation, medical morbidity, and dry eye symptoms; it is possible occupation might cause the comorbidities rather than being chosen as a result of the comorbidities. Secondly, the type of occupation (but not working hours) was inferred from a questionnaire completed at baseline, so not at the time of dry eye assessment. Although this has the advantage of ensuring sufficient exposure time before observing dry eye symptoms, a small proportion of employed people may have switched to another type of occupation leading to misclassification of their occupation. A strength of this study is the unprecedented large sample size which made it possible to look at major and sub-major groups of occupations separately, which has not been investigated before. Other strengths are the systematic classification of occupations and the correction for all comorbidities and traits that could have introduced potential bias. Correction for important confounders, such as contact lens use, is lacking in most other studies that investigated environmental risk factors of dry eye, and our findings underline the importance of addressing this.

5. Conclusions

In conclusion, this large-scale study showed a clear association between the type of occupation and symptomatic dry eye, with a clearly lower risk of symptomatic dry eye in outdoor and active occupations, even when corrected for comorbidities and contact lens use. Sedentary occupations and jobs associated with VDT use showed the highest prevalence of symptomatic dry eye, but this is largely mediated by high contact lens use in these employees, while building workers and metal and machinery workers were associated with the highest risk of dry eye, taking into account demographics, comorbidities and contact lens use. Screening for symptomatic dry eye in these occupations may be useful, not only from an occupational health perspective but also from a work productivity perspective. The current findings also underline the importance of taking a thorough occupational and social history in patients with dry eye disease, to better understand the aetiology of symptoms. Furthermore, we encourage further studies on the possible protective effects of outdoor exposure and physical activity on patients with symptomatic dry eye.

Disclosure/conflicts of interest statement


Acknowledgments

The authors wish to acknowledge the services of the Lifelines Cohort Study, the contributing research centres delivering data to Lifelines, and all the study participants.

The Lifelines Biobank initiative has been made possible by funds from FES (Fonds Economische Structuurversterking), SNN (Samenwerkingsverband Noord Nederland) and REP (Ruimtelijk Economisch Programma). FES, SNN and REP had no role in the collection, analysis and interpretation of the data; in the writing of the report; and in the decision to submit the paper for publication.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jtos.2019.04.004.

References


International standard classification of occupations (ISCO-08).http://www.ilo.org/

Jones R, Elias P. CASCOT: computer-assisted structured coding tool. Institute for
Employment Research, Coventry, University of Warwick. https://warwick.ac.uk/
fac/soc/ier/research-tools/.

Carter JB, Banister EW. Musculoskeletal problems in VDT work: a review.

Burkhart G, Schulte PA, Robinson C, Sieber WK, Vossenas P, Ringen K. Job tasks,
potential exposures, and health risks of laborers employed in the construction in-

Arndt V, Rothenbacher D, Daniel U, et al. Construction work and risk of occupa-
tional disability: a ten year follow up of 14 474 male workers Occupational and.

Carino M, Romita P, Foti C. Allergy-related disorders in the construction industry.

Owen N, Bauman A, Brown W. Too much sitting: a novel and important predictor of

Hamilton MT, Hamilton DG, Zderic TW. Role of low energy expenditure and sitting

Healy GN, Dunstan DW, Salmon J, et al. Breaks in sedentary time: beneficial asso-

Lee IM, Shiroma EJ, Lobelo F, Puska P, Blair SN, Katzmarzyk PT, et al. Effect of
physical inactivity on major non-communicable diseases worldwide: an analysis of

Kawashima M, Uchino M, Yokoi N, Uchino Y, Dogru M, Komuro A, Sonomura Y,
Kato H, Nishiwaki Y, Kinoshita S, Tsubota K. The association between dry eye
disease and physical activity as well as sedentary behavior: results from the Osaka

Epub 2014 Nov 17.

Geneen LJ, Moore RA, Clarke C, Martin D, Colvin IA, Smith BH. Physical activity
and exercise for chronic pain in adults: an overview of Cochrane Reviews. Cochrane

Reddy P, Grad O, Rajagopalan K. The economic burden of dry eye: a conceptual

Nichols KK, Bacharach J, Holland E, et al. Impact of dry eye disease on work pro-

Patel VA, Watanabe JH, Strauss JA, Dubey AT. Work productivity loss in patients

Yamada M, Mizuno Y, Shikeyasu C. Impact of dry eye on work productivity. Clin

and conjunctival alterations in operating room workers: a single-institution pilot
study. Int Arch Occup Health 2001;74(1).

Butzon SP, Eagels SR. Prescribing for the moderate-to-advanced ametropic pres-
byopic VDT user. A comparison of the Technica Progressive and Datalite CRT tri-

Blehm C, Vishnu S, Khattak A, Mitra S, Yee RW. Computer vision syndrome: a re-