



The Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) global pandemic has dramatically changed every aspect of life during 2020/2021. In the UK, the government imposed the first national lockdown on the 23 March 2020 asking the general public to stay at home. This action has resulted in an increase in the time spent indoors and in a reduction of motor vehicle usage of up to 65% of normal (Higham et al., 2020). In the UK, road traffic contraction has led to up to a 30% decrease in most of the air pollutants (Lee et al., 2020) such as nitrogen dioxides (NO₂), nitrogen oxides (NO_x), particulate matter 2.5 µm (PM₂₅) and 10 µm (PM₁₀), except ozone (O₃) which showed a 30% increase (Shi et al., 2021). During the first UK lockdown, ocular surface disease (OSD) patients treated with systemic immunosuppression were defined as coronavirus ‘high-risk’ and fulfilled the government criteria for shielding for a minimum of 12 weeks. Our aim was to evaluate whether the first UK COVID-19 lockdown measures changed the air pollution levels and OSD symptomatology relationship amongst shielding patients.

Thirty-five OSD patients (median age 70, 17 (48.5%) females and 18 (51.5%) with severe ocular surface disease maintained on systemic immunosuppression achieved a risk stratification score of >3 defined as coronavirus 'high-risk', fulfilled the UK government criteria for shielding for a minimum of 12 weeks, were included. Of these, 22(63%) ocular mucous membrane pemphigoid; 3(9%) high-risk corneal transplant recipients; 4(12%) ulcerative keratitis; 2(6%) Stevens-Johnson syndrome; 3(9%) other (granulomatous polyangiitis, Sjögren's syndrome, pemphigus vulgaris). Symptoms and air pollutions data were considered from three different time periods categorised as 'pre', 'during' and 'post-lockdown'.

'Pre-lockdown' symptoms were curated from hospital electronic databases using the OSDI® symptom questionnaire (Allergan plc, Irvine, CA)

The authors declare that they have no conflict of interest.



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'During' and 'Post-lockdown' data were obtained via postal hardcopy. 'Air pollution' data for patient residential postcodes were derived from *Department for Environment, Food, & Rural Affairs* (DEFRA) and from the *Automatic Urban and Rural Network* (AURN) monitoring network for NO₂, NO_x, PM_{2.5} and PM₁₀.

The study was conducted following the Declaration of Helsinki ethical principles and approval was obtained from *Sandwell and West Birmingham NHS Trust* Department of Clinical Effectiveness (Registration #1611) to undertake this research.

A significant reduction of NO₂ (35%, from 17.11±6.87 to 11.17±4.79, p<0.001) and NO_x (44%, from 26.06±11.64 to 14.53±7.18, p<0.001) respectively, were observed between 'pre' and 'during' lockdown periods. Conversely, a 12% increase in symptom scores were recorded 'during' versus 'pre' periods (36.11±16.09 vs 32.24±29.17, p=0.381); that was followed by a 19% fall in OSDI scores between the 'during' and 'post' periods (36.11±16.09 vs 29.46 ± 26.29, p=0.144). There was no correlation between dry eye symptoms and pollutants across all the considered periods (Table 1).



Spearman's rho r correlations	NO ₂	NOx	PM25	PM10
OSDI PRE	-0.023	-0.022	-0.070	-0.068
p-value	0.897	0.896	0.689	0.791
OSDI DURING	-0.124	-0.127	-0.151	-0.169
p-value	0.477	0.469	0.387	0.394
OSDI POST	-0.114	-0.122	-0.089	-0.091
p-value	0.567	0.431	0.614	0.387
N	35	35	35	35

Table 1 Correlations dry eye symptoms (OSDI®) and air pollutants



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The first UK national lockdown due to the SARS-CoV-2 pandemic posed a new challenge for ophthalmic practitioners specialising in ocular surface disease and severe dry eye disease patients. The number of face-to-face hospital consultations were reduced to avoid the spread of the disease. In particular, the follow-up visits were converted to virtual video or telephone consultations, as many patients taking systemic immunosuppression regimens were defined as coronavirus 'high-risk' and the UK government had advised to shield at home.

However, the reduction of motor vehicle usage due to the lockdown measures, led to a decrease in air pollutants which are not only responsible for developing health respiratory conditions (such as asthma and pulmonary disease), but also dry eye disease.

This study explored the possibility of whether changes in air pollutions levels due to lockdown measures were linked with improved OSD symptomatology experienced by a cohort of systemic immunosuppressed patients in different time periods ('Pre', 'During', and 'Post' first national lockdown). Although there were significant reductions of some of the air pollutants considered (NO₂ and NO_x), the immunosuppressed OSD patients surprisingly showed an increase in their ocular symptoms. This might be due to a range of environmental factors such as increased use of blue screen electronic devices such as computers, tablets and smartphones during the lockdown periods, as well as the psychological impact of lockdown on patient wellbeing due to the lack of social interaction and increased seclusion, leading to anxiety and depression and increased symptomatology.



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