The impact of air pollution on ocular surface disease symptoms during the COVID-19 UK lockdown

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RCOphth Annual Congress 2021 Poster Submission Code rco2021.05d0185 64

Purpose

During the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) pandemic, the UK government imposed the first national lockdown on the 23 March 2020 asking the general public to stay at home. This action 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). The contraction in road traffic led to around 30% decrease in most air pollutants (Lee et al., 2020) such as nitrogen dioxides (NO_2), nitrogen oxides (NOx), particulate matter 2.5 µm (PM25) and 10 µm (PM10), except ozone (O_3) which showed a 30% increase (Shi et al., 2021). During the lockdown period, ocular surface disease patients with dry eye disease (DED) 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 altered air pollutants and whether these changes impacted on DED symptomatology amongst shielding patients.

Methods

Symptoms and air pollution data for three different time periods (Pre, During and Post-lockdown) were analysed for thirty-five DED patients (median age 70(range 42-85) years; 17(48.5%) females; 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. All patients were maintained on systemic immunosuppression, achieved a risk stratification score >3 and fulfilled the UK Government criteria for shielding. 'Pre' clinical data were curated from electronic medical records, and 'During' / 'Post-lockdown' data were obtained via postal hardcopy of the OSDI© symptom questionnaire (Allergan plc, Irvine, CA). Patient residential postcode 'Air pollution' data were derived from *Department for Environment, Food, & Rural Affairs* (DEFRA) and from the *Automatic Urban and Rural Network* (AURN) monitoring network. [continue →]

Nitrogen dioxides (NO2), nitrogen oxides (NOx), 2.5µm (PM25) and particulate matter 10µm (PM10) data were correlated with residential postcodes and the OSDI© symptom score.

This 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.

Results

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

'Pre' and 'During' lockdown periods showed a significant reduction of NO_2 (35%, from 17.11±6.87 to 11.17±4.79, p<0.001) and NOx (44%, from 26.06±11.64 to 14.53±7.18, p<0.001), respectively. 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% reduction in OSDI scores between the 'During' and 'Post' periods (36.11±16.09 vs 29.46 ± 26.29, p=0.144). No correlation were found between dry eye symptoms and pollutants across all the considered periods (**Table 1**).

Conclusions

Ophthalmic practitioners specialising in ocular surface disease and severe dry eye disease patients had to face a new challenge during the first UK national lockdown due to SARS-CoV-2 pandemic.

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.

The current research explored the possibility of whether changes in air pollution levels due to lockdown measures were linked with improved DED symptomatology experienced by a cohort of systemically 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 (NO_2 and NOx), the immunosuppressed DED patients surprisingly, showed an increase in their ocular symptoms. The potential reason behind that change might be due to a range of environmental factors such as increased use of blue screen electronic devices including 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.

Disclosure

The authors declare that they have no conflict of interest.



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Acknowledgements

Alberto Recchioni (AR) is supported by funding from the II-LA-1117-20001 Programme Invention for Innovation (i4i), National Institute for Health Research (NIHR)*.
Maryam Makanvand (MM) and William Bloss (WB) are supported by the Natural Environment Research Council (NERC).
Saaeha Rauz (SR) is supported by is supported by National Institute for Health Research (NIHR) Programme Invention for Innovation (i4i), Medical Research Council (MRC) Developmental Pathway Funding Scheme (DPFS), Fight for Sight, Sandwell and West Birmingham Hospitals National Health Service Trust.
Graham Wallace (GW) is supported by Medical Research Council and Fight for Sight.
*This is a summary of independent research funded by the NIHR's i4i Programme. Views expressed are those of the authors and not necessarily those of the NHS, the NIHR or DHSC.