

Short and mid-term impact of ozone on myocardial infarction incidence in Poland



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We appreciate the commentary by Mark R. Miller on our analysis.^{1,2} As a research group focused on investigating, gathering, and spreading scientific evidence on detrimental effects of air pollution on human health, we strongly support the author's viewpoint.

In the comment, the issue of potentially negative impact of ozone (O₃) was raised. Although initially this gaseous pollutant was omitted due to our focus on constituents of Polish Smog, we have been able to supplement our recent paper regarding the impact of O₃ on myocardial infarction (MI) incidence, using the previously described methodology.² This is particularly relevant given recent data demonstrating the adverse effects of O₃ on the incidence of cardiovascular disease (CVD).^{S1}

In our study, the median concentration of O₃ was 47.9 µg/m³ (IQR 34.3–60.9) with great seasonal and geographical variability. The exposure to O₃ increased the risk of ST-elevation MI incidence on the day of exposure (RR 1.007, 95% CI 1.001–1.013, P = 0.026), especially in the rural areas (RR 1.009 95% CI 1.002–1.016, P = 0.009), with no effect on non-ST-elevation MI (Fig. 1).

In Polish smog, the main pollutants are particulate matter (PM) and polyaromatic hydrocarbons, mainly from burning low-quality fuels in residential furnaces. In rural areas, much of the air pollution comes from agriculture, emitting ammonia and NO_x, which can convert into PM. Tropospheric O₃ forms from photochemical reactions between NO_x and volatile organic compounds. However, in areas with high NO_x concentrations, O₃ reacts with NO, forming NO₂ and O₂, reducing O₃ levels. This dynamic balance means areas with high NO_x concentrations typically have lower O₃ levels, which is common in many urban areas.^{S2,S3}

There are a limited number of studies assessing the differences arising from the influence of individual air

pollution on the incidence of CVD comparing rural and urban areas.³ However, larger associations between mean air pollution concentrations and the incidence of CVD were observed in rural communities.³ Another study by Su et al. examining the impact of O₃ demonstrated that female and rural residents face a heightened risk.⁴ O₃ may be especially harmful in patients who have at least one cardiovascular risk factor, including atherosclerotic lesions, which may explain differences in its impact between various populations—as seen in our results.⁵ On the contrary, there are studies of O₃ and MI that did not find any significant influence or even a protective effect.^{S4,S5}

We believe that a new era of shifting the paradigm in CVD prevention is upon us, signaling the necessity to integrate environmental risk factors into established risk assessment scales, alongside extending mitigation strategies to encompass less urbanized area.

Contributors

Conceptualization, funding acquisition, methodology, project administration, investigation, validation and visualization were performed by Ł.K. Data curation and formal analysis were performed by Ł.K., M.Ś., E.J.D. All authors contributed to the writing of original draft, review and editing. Ł.K., S.D., G.Y.H.L. supervised the project.

Ł.K. and G.Y.H.L. directly accessed and verified the underlying data reported in the manuscript.

All authors had full access to all the data in the study, read and approved the final manuscript.

Data sharing statement

Data used for all analyses and analytic code whenever applicable are available from the corresponding author upon reasonable request.

Declaration of interests

GYHL: Consultant and speaker for BMS/Pfizer, Boehringer Ingelheim, Daiichi-Sankyo, Anthos. No fees are received personally. He is a National Institute for Health and Care Research (NIHR) Senior Investigator and co-PI of the AFFIRMO project on multimorbidity in AF (grant agreement No 899871), TARGET project on digital twins for

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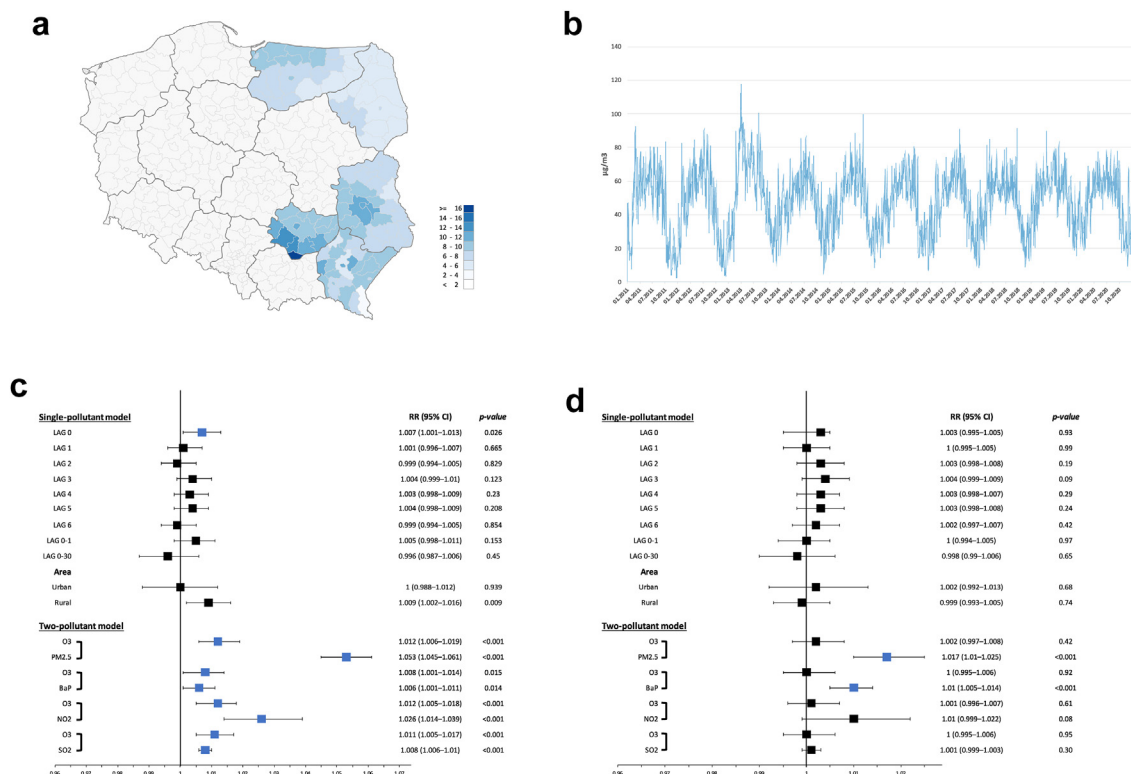


Fig. 1: Impact of ozone on myocardial infarction incidence in the analyzed region. Panel a, O₃ concentrations in individual counties within the analyzed area. Panel b, O₃ concentrations over the analyzed period. Panel c, association between exposure to O₃ and STEMI incidence. Panel d, association between exposure to O₃ and NSTEMI incidence. In two pollutant models, the effects were adjusted for pollutants other than O₃. Abbreviations: BaP, benzoalaphapylene; O₃, ozone; NO₂, nitrogen dioxide; PM_{2.5}, particulate matter with an aerodynamic diameter less than 2.5 microns; RR, relative risk; SO₂, sulfur dioxide.

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The study was registered at ClinicalTrials.gov (NCT05198492).

Appendix A. Supplementary data

Supplementary data related to this article can be found at <https://doi.org/10.1016/j.lanepe.2024.100982>.

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