

Air pollution is linked to lower COVID-19 vaccine responses

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People exposed to higher levels of air pollution before the pandemic had lower antibody responses to COVID-19 vaccines, according to a study led by the Barcelona Institute for Global Health (ISGlobal), in

collaboration with the Germans Trias i Pujol Research Institute (IGTP). In particular, exposure to fine particulate matter (PM_{2.5}), nitrogen dioxide (NO₂) and black carbon (BC) was associated with about a 10% decrease in IgM and IgG antibody responses in people without prior infection.

The findings, published in *Environmental Health Perspectives*, provide further evidence on the adverse effects of air pollution on the [immune system](#).

Air pollution has been linked to adverse health outcomes, including lung cancer, cardiovascular and respiratory disease, and diabetes. Recently, ISGlobal researcher Manolis Kogevinas and his team showed an association between pre-pandemic exposure to [air pollution and a higher risk of developing severe COVID-19](#).

"Air pollutants have been shown to affect immune responses," says Kogevinas, "so in this study we wished to determine whether air pollution also affects antibody responses to COVID-19 vaccines." The answer, in a nutshell, is yes.

Antibody responses: Slower and lower

Kogevinas and his colleagues analyzed data from 927 participants of the [GCAT Genomes for Life](#) cohort (aged 40 to 65 years), who answered questionnaires and gave [blood samples](#) in the summer of 2020 (right after the first lockdown) and in the spring of 2021 (after the start of COVID-19 vaccination). All had received one or two doses of the main COVID-19 vaccines administered in Spain (made by AstraZeneca, Pfizer or Moderna).

The research team measured IgM, IgG and IgA antibodies to five viral antigens (three of them on the Spike protein contained in the [vaccine](#)).

Exposure to [fine particulate matter](#) (PM_{2.5}), [black carbon](#) (BC), [nitrogen dioxide](#) (NO₂) and ozone (O₃) was estimated for each participant based on his or her address before the pandemic.

"The collaboration of all volunteers in the GCAT cohort, with more than ten years of data, has allowed us to reliably estimate the level of environmental exposure of all participants," says Rafael de Cid, co-author of the study and GCAT|Genomes for Life (IGTP) project director.

The results show that in uninfected individuals, pre-pandemic exposure to PM_{2.5}, NO₂ and BC was associated with a 5% to 10% reduction in vaccine-induced spike antibodies. The decrease in antibodies was shown both for early IgM responses and late responses measured by IgG. The IgG response after the first dose peaked later in participants exposed to higher air pollution levels, and lower IgG levels persisted for several months after vaccination. Results were similar for the three vaccines.

"Air pollution can induce chronic inflammation, which has been associated with a negative effect on vaccine efficacy," explains Carlota Dobaño, co-senior author of the study, together with Cathryn Tonne. "Our findings are consistent with evidence that [persistent organic pollutants](#) reduce vaccine responses in children," she adds.

The fact that previous infections lead to higher vaccine responses could explain why the effect of pollutants was only observed in people without a prior infection. However, the role of long-term exposure to air pollution on hybrid immunity (infection plus vaccination) deserves further investigation, the authors warn.

The study did not look at whether the reduction in antibody responses led to an increased risk of breakthrough infections and their severity.

"However, our findings add to growing body of evidence on the adverse

effects of air pollution even at the relatively low levels observed in Western Europe. They also call for stricter [air pollution](#) limits, as recommended by the WHO," says Tonne.

This study is part of COVICAT (COVID Cohort in Catalonia), a collaborative inter-institutional project by ISGlobal and IGTP to assess the health impact of the COVID-19 pandemic on the Catalan population and which is now in its third follow-up edition.

More information: Long-term exposure to air pollution and COVID-19 vaccine antibody response in a general population cohort (COVICAT Study, Catalonia), *Environmental Health Perspectives* (2023). [DOI: 10.1289/EHP11989](https://doi.org/10.1289/EHP11989)

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