

Deliverable D12 (D2.4)

Added value of oxidative potential to assess health exposure to air pollution



RI-URBANS

**Research Infrastructures Services Reinforcing Air
Quality Monitoring Capacities in European Urban &
Industrial AreaS (GA n. 101036245)**

By

ISGlobal, CNRS & NOA



18 December 2024

Deliverable D12 (D2.4): Added value of oxidative potential to assess health

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Work package (WP)	WP2 Health effect assessment of PM, PM components, nanoparticles, and their source contributions
Deliverable	D12 (D2.4)
Lead beneficiary	ISGlobal
Deliverable type	☒ R (document, report) ☐ DEC (websites, patent filings, videos,...) ☐ Other: ORDP (open research data pilot)
Dissemination level	☒ PU (public) ☐ CO (confidential, only members of consortium and European Commission)
Estimated delivery deadline	M39 (December 2024)
Actual delivery deadline	18/12/2024
Version	Final
Reviewed by	WP2 leaders
Accepted by	Project Coordination Team
Comments	This deliverable addresses T2.1 on the Improved evaluation of health effects in epidemiologic time series studies.

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1. About this document

RI-URBAN's WP2 focuses on evaluating the use of measurements of new air quality (AQ) metrics, including Oxidative Potential (OP), for improved health impact assessment and epidemiological health studies.

This deliverable addresses T2.1 on the Improved evaluation of health effects in epidemiologic time series studies. Here OP data are used to complement data on regulated pollutants (PM_{2.5}, PM₁₀, NO₂) for epidemiological studies to demonstrate the added value of OP beyond routinely measured pollutants. T2.1 links the time series of OP to those of daily mortality.

This document contains results from an epidemiological study in which a random effect meta-analysis was conducted to summarise the short-term associations between the OP of particulate matter (PM) from different size fractions and daily mortality counts in six European regions, namely Athens (GR), Barcelona (ES), Isère (FR), Grenoble (FR), Paris (FR), and Zurich (CH) using data collected between 2013 and 2022.

This is a public document that will be distributed to all RI-URBANS partners for their use and submitted to the European Commission as a RI-URBANS deliverable D12 (D2.4). This document can be downloaded at <https://riurbans.eu/work-package-2/#deliverables-wp2>

2. Introduction

Outdoor air pollution is considered carcinogenic by the World Health Organization (IARC - WHO, 2015) and affects mortality both related to long-term and short-term exposure. Air pollution therefore poses a serious threat to public health. Air pollution is a complex mixture of both gases and aerosol particles of different sizes, chemical composition and physical state. Particulate matter (PM), an important constituent of the air pollution mixture, is independently associated with a wide range of diseases including respiratory and cardiovascular disease (Thurston et al., 2017). However, the existing scientific evidence on which PM properties have the strongest potential to cause the observed health effects is still inconclusive. One of the mechanisms by which PM may adversely affect health is through oxidative stress. PM has the potential to generate free radicals, such as reactive oxygen species (ROS), in the human body causing oxidative stress and consequently adverse health effects (Sánchez et al., 2024). Such oxidative stress can be evaluated through the oxidative potential (OP) of PM that can quantify exogenous oxidative stress brought by PM during inhalation as an initial step of subsequent downstream processes.

One method to quantify the OP of PM is by quantifying PM's capacity to consume lung antioxidant molecules from synthetic airway fluids (Dominutti et al., 2023 and references therein). OP is commonly estimated by adding an antioxidant agent to a PM sample and then estimating the loss in antioxidant agent as time elapses (Fang et al., 2016; Sánchez et al., 2024). Antioxidant agents often used are dithiothreitol (DTT) and ascorbic acid (AA). While both reagents are used to estimate OP, these reagents may yield contrasting results depending on the chemical composition of the analysed PM sample (Fang et al., 2016). Transition metals (e.g., iron and copper), and organic compounds (e.g., OC), as well as physical properties like solubility are among the driving forces for the response of PM in OP assays (Gao et al., 2020).

OP is an unregulated PM metric and is recommended now in the new framework of the European Directive 2024/2881 for additional monitoring. OP has been associated with serious health effects including lung cancer,

diabetes, pediatric asthma and child lung function (Delfino et al., 2013; Marsal et al., 2023; Strak et al., 2017; Weichenthal et al., 2016; Yang et al., 2016). In Grenoble, France, recent studies done on the SEPAGES mother-child cohort found associations between personal maternal exposure to OP DTT and birth weight (Borlaza et al., 2023), but also between personal maternal exposure to OP DDT and OP AA and objective lung function parameters measured at 6 weeks (Marsal et al., 2023). In addition, personal maternal exposure to OP AA was associated with a higher level of a biomarker of oxidative stress (8-OHdG) during the pregnancy (Marsal et al., 2024). Although some studies have observed significant associations between OP and health outcomes (He and Zhang, 2023), results do not always agree in terms of absolute values due to the early stage of the harmonization process ([Deliverable D11 \(D2.3\)](#), providing a standardised OP DTT protocol).

Evidence on the short-term health effects of OP is still very limited and very few time-series have been performed focusing on short-term effects of OP. In Europe, Atkinson et al. (2016) found little or no evidence of a relationship between OP from AA or OP from glutathione (GSH) and daily counts of emergency room admissions for respiratory or CVD disease and all-cause mortality in the city of London. In studies carried out in the city of Atlanta, United States, OP from DTT assays were positively associated with emergency department visits for respiratory disease, asthma/wheeze, congestive heart failure and ischemic heart disease (Abrams et al., 2017; Bates et al., 2015). An additional study using the same dataset, concluded that when applying the AA assay (instead of DTT) no associations with asthma, wheeze or congestive heart failure were found (Fang et al., 2016). More details on OP measurement techniques can be found in [Deliverable D11 \(D2.3\)](#).

THE METHODOLOGY AND RESULTS OF THIS DELIVERABLE ARE NOT INCLUDED HERE BECAUSE AUTHORS REQUESTED AN EMBARGO FOR THE PUBLIC ACCES TO THESE BECAUSE A SCIENTIFIC ARTICLE IS BEING SUBMITTED FOR PUBLICATION. THE COMPLETE DELIVERABLES ARE AVAILABLE IN THE EC H2020 PORTAL OF THE PROJECT AND WERE SUPPLIED IN THE DUE TIME. WHEN THE ARTICLES WILL BE PUBLISHED THE FULL DELIVERABLE WILL BE OPENLY AVAILABLE.