



MARKOPOLO

Noise and/or ultrafine particulate matter induced cerebral and cardiovascular damage: novel insights from experimental and epidemiological brain-heart axis biomarkers and computational models

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Collaboration plan

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SUMMARY

This document outlines the progress of cross-project working groups and other collaborative efforts within the MARKOPOLO project. It provides an overview of key activities from joint initiatives implemented during the first 12 months of the project. The report also highlights planned next steps to strengthen synergies and ensure continued alignment with the project's strategic objectives.

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1 INTRODUCTION

1.1 Purpose and Scope

The purpose of this document is to present the progress achieved through cross-project working groups and other collaborative initiatives within the MARKOPOLO project. It summarizes the main activities and outcomes of joint efforts carried out during the first 12 months of implementation. Furthermore, it defines the plan and actions aimed at enhancing collaboration, fostering synergies, and maintaining alignment with the overarching strategic goals of the project.

1.2 Definitions, Abbreviations and Acronyms

Abbreviation	Full Name
BC	Black Carbon
BDNF	Brain-Derived Neurotrophic Factor
CO ₂	Carbon Dioxide
Cyl	Cyprus Institute
DCS	Danish Cancer Society
DIA	Data-Independent Acquisition (proteomics)
DTA	Data Transfer Agreement
EMAC	ECHAM/MESSy Atmospheric Chemistry model
FFPE	Formalin-Fixed Paraffin-Embedded
GSH	Reduced Glutathione
GSSG	Oxidized Glutathione
IHD	Ischaemic Heart Disease
JMU	Julius-Maximilians-Universität Würzburg
KM-SUB-ELF	Kinetic Multi-layer Surface and Bulk chemistry model for the Environmental and Living Facility
LDSA	Lung-Deposited Surface Area
LIH	Luxembourg Institute of Health
LNS	Laboratoire National de Santé
MAO-A	Monoamine Oxidase A
MAO-B	Monoamine Oxidase B
MFUB	Medical Faculty, University of Belgrade
MPI-C	Max Planck Institute for Chemistry
MTA	Material Transfer Agreement
MUSC	Medical University of South Carolina
NO ₂	Nitrogen Dioxide
PFA	Paraformaldehyde
PNC	Particle Number Concentration
PM2.5	Particulate Matter $\leq 2.5 \mu\text{m}$
RNA	Ribonucleic Acid
SDU	University of Southern Denmark
SOP	Standard Operating Procedure
SPPI	Science–Policy–Practice Interface
Swiss TPH	Swiss Tropical and Public Health Institute
TB	Terabyte
TMA	Tissue Microarray
TrkB	Tropomyosin Receptor Kinase B

UEF	University of Eastern Finland
UFP	Ultrafine Particles
UMC-Mainz	University Medical Center Mainz
UNIPD	University of Padua
VMU	Vytautas Magnus University
VINS	Vinča Institute of Nuclear Sciences
WP	Work Package

2 COLLABORATIONS WITHIN MARKOPOLO

2.1 Overview of collaborations per partner

2.1.1 UMC-Mainz (Cardiology)

Recent collaboration:

UMC-Mainz (Cardiology) transferred approximately 2 TB of RNA-sequencing data from previous mouse exposure studies to **LIH** for in-depth bioinformatic analysis. The dataset covers multiple exposure regimens and organs. **LIH** harmonizes these datasets, compares biomarkers across organs, time points and exposure durations, and expands the transcriptomic information by integrating proteomics data from earlier joint studies with **UMC-Mainz** (aorta and heart, with plasma pending). **LIH** will further complement the dataset with proteomic profiles from additional organs and plasma provided by **SDU**, enabling an integrated comparison of transcriptomic and proteomic biomarkers.

UMC-Mainz (Cardiology) sent frozen samples from previously published studies – each with validated functional and biochemical effects of specific exposures - to several partners:

- 45 lung, heart and brain-cortex samples to **SDU** for proteomic analysis from the study comparing nano- versus microparticle toxicity in mice (PMID: 40319735).
- 60 lung, heart and brain-cortex samples to **SDU** for proteomic analysis from the study comparing noise, PM2.5 and combined noise+PM2.5 exposures (PMID: 36566737).
- 25 brain-cortex samples to **SDU** for proteomic analysis from the study evaluating different noise-exposure durations (PMID: 35174211).
- 60 lung, heart and brain-cortex samples to **UMC-Mainz (Neuropathology)** - previously **LNS** - for epigenetic analysis from the study comparing noise, PM2.5 and combined exposures (PMID: 36566737).

The ongoing analyses strongly confirm the previously published findings and reveal numerous new biomarkers that deepen mechanistic insight, highlight emerging pathophysiological hypotheses and provide promising candidates for robust detection and quantification of exposure-related health effects.

UMC-Mainz (Cardiology) also distributed frozen samples from a recent study (August–September 2025) examining functional and biochemical effects of noise, UFP and combined noise + UFP exposures:

- 425 samples (covering lung, heart, liver, spleen, kidney, adrenals, multiple brain regions and plasma) to **SDU** for proteomic analysis of separate and combined noise/UFP effects.
- 80 plasma, brain-cortex and olfactory-bulb samples to **UEF** to investigate markers of the brain–heart axis and perform deep plasma metabolomics in the same study.
- an additional 32 plasma samples to **UEF** to examine brain–heart axis markers in a study on health effects of carbon-black particles of different sizes.

- 118 PFA-fixed lung, heart, spleen, kidney and brain-cortex samples to **UMC-Mainz (Neuropathology)** - previously **LNS** - for immunohistochemical analysis from the study comparing noise, PM2.5 and combined exposures (PMID: 36566737).

UMC-Mainz (Cardiology) also reported a number of MARKOPOLO-relevant publications, lectures at international meetings, press releases, training activities within summer schools and master programs to **concentris** for social media and MARKOPOLO webpage presentation. These dissemination activities will be continued in the future.

Planned collaboration:

UMC-Mainz (Cardiology) planned shipments of frozen samples from a recent study (August/September 2025) with some validation of functional and biochemical effects of noise, UFP, noise+UFP exposures to different partners:

- 60 lung, heart and brain cortex samples will be sent to the partner **UNIPD** for markers of brain-heart axis (MAOs and BDNF/TrkB) from the study comparing separate and combined noise/UFP health effects in mice.
- 60 lung, heart and brain cortex samples will be sent to the partner **MUSC** for markers of brain-heart axis (ApoE, p-Tau, BDNF/TrkB) from the study comparing separate and combined noise/UFP health effects in mice.
- A number of plasma and tissues samples will be sent to the partner **LNS** for markers of oxidative stress (GSH/GSSG) from the study comparing separate and combined noise/UFP health effects in mice.

2.1.2 UMC-Mainz (Neuropathology)

UMC-Neuropathology has received 118 samples from **UMC-Mainz (Cardiology)** to date, including brain hemispheres (n=22), samples from lung (n=22), heart (n=25), spleen samples (n=25), and kidney (n=24).

FFPE tissue blocks were created, and initial overview staining was performed for histological tissue assessment and selection of specific regions for TMA creation, which are required for subsequent spatial biology analyses.

Frozen samples are expected from **UEF** (n=24) and **UMC-Mainz (Cardiology)** (n=60) for DNA extraction and subsequent DNA methylation analyses in December 2025.

2.1.3 Cyprus Institute & Max Planck Institute for Chemistry

The Cyprus Institute (Cyl) has produced high-resolution concentration maps of UFP pollution at the global scale based on machine learning techniques that leverage ground-based monitoring data and Earth observations, e.g., from satellites. This is combined with UFP calculations with the chemistry-climate model EMAC (ECHAM5/MESSy for Atmospheric Chemistry) (PMID: 40319735 for 10km x 10km resolution, PMID: 41238666 for 1km x 1km resolution) to assess UFP sources. The combined data sets are used in health impact assessments.

Concentration for PM2.5 as well as its components have been produced for the year 2009 as daily values and distributed to the Max Planck Institute for Chemistry (**MPI-C**), to investigate the possible use with the KM-SUB-ELF model as input data.

2.1.4 University of Southern Denmark

University of Southern Denmark (SDU) contributed to MARKOPOLO by supporting the establishment and maintenance of cross-project working structures that ensure coherence between sample generation, omics analyses, data harmonisation, and bioinformatics integration. Within the scope of WP9, WP10, and WP11, SDU plays an active role in strengthening collaboration between partners who generate biological material, perform omics workflows, and develop data integration tools.

SDU co-organises and participates in the regular omics data harmonisation meetings that coordinate sample flow, methodological alignment, and metadata consistency across centres. Together with **LIH**, **SDU** maintains the shared proteomics and metadata framework used by partners in WP9 and WP10, ensuring that data produced by different laboratories follow harmonised formats and quality standards. **SDU** also contributes to the cross-WP alignment between experimental work packages and WP11 by regularly exchanging processed datasets, quality metrics, and workflow updates with computational partners.

As part of the consortium's collaborative structure, **SDU** actively engages in the Data Hub meetings held every second Monday. These meetings serve as a central platform for coordinating sample handling, data storage, transfer procedures, and GDPR-compliant data management across partners.

SDU also contributes to the Omics Data Analysis and Results Working Group, which meets bi-weekly and focuses on harmonisation of DIA proteomics workflows, cross-centre quality control, and biological interpretation of emerging results.

Finally, **SDU** facilitates collaboration through timely communication with partners (e.g. UMC-Mainz) sending samples or receiving processed data, through updates to the shared master metadata tables, and through practical support for the implementation of SOPs and data standards. These activities directly support and contribute to stable, transparent, and well-functioning cross-WP working arrangements.

2.1.5 Swiss Tropical and Public Health Institute & Danish Cancer Society

To support day-to-day coordination, WP4 meetings - including **Swiss Tropical and Public Health Institute (Swiss TPH)**, **Danish Cancer Society (DCS)**, **Vytautas Magnus University (VMU)**, and **Medical Faculty, University of Belgrade (MFUB)** — are held online on a monthly basis.

Swiss TPH, **DCS** and **VMU** have established close collaboration within MARKOPOLO through the design and implementation of an international mobile measurement campaign for ultrafine particle number concentration (PNC) and other air pollutants (PM_{2.5}, black and brown carbon, CO₂, NO₂, temperature, humidity, and lung-deposited surface area (LDSA)). Using a harmonised mobile monitoring platform, the partners have so far collected approximately 6,500 km of measurements in Switzerland, 1,500 km in Lithuania, and 5,100 km in Denmark. Additional campaigns in different seasons will be conducted to capture temporal variability. The coordinated design of these mobile campaigns ensures streamlined data collection, consistent metadata structures, and comparable measurement outputs across MARKOPOLO countries.

Swiss TPH leads the centralised data management and data harmonisation for the Swiss and Danish campaigns, which share a similar national-scale geographical scope (full coverage of Switzerland and the Zealand region in Denmark). Many of the predictors required to build UFP exposure models are available at a European level. **Swiss TPH** will derive these predictors jointly for Switzerland and Denmark, enabling comparable modelling frameworks across countries. Each partner is responsible for collecting data on local predictors such as traffic

activity and the presence of wood-burning stoves within their respective regions. To ensure consistency and comparability of these variables, the Swiss and Danish teams will maintain regular correspondence and hold online coordination meetings. Harmonised protocols will be jointly developed and implemented, ensuring that data collection, quality control, and data cleaning are carried out in a consistent manner across both Denmark and Switzerland.

The global dispersion modelling effort developed by the **Cyprus Institute (Cyl)** — providing pollutant estimates at a 1 × 1 km resolution — will constitute an additional possible basis for the MARKOPOLO exposure assessment pipeline. **Swiss TPH** will use these global models (available 2010-2019) as one of many inputs to derive a measurement-based high-resolution 25 × 25 m grid by integrating local environmental predictors and the mobile monitoring data. We will look to back-extrapolate these models based on long-term monitoring data for the years 2000-2024. This collaboration ensures methodological alignment across partners and supports the development of robust, harmonised UFP exposure models.

In terms of health analyses (WP5), **Swiss TPH** will investigate long-term outcomes for brain tumours as well as short-term outcomes for fatal strokes and brain tumours within the Swiss National Cohort. The **DCS** will investigate long-term effects of noise and air pollution on 1) risk of cardiometabolic diseases among people with preexisting CVD, 2) effects of moving on risk of ischaemic heart disease (IHD), and 3) cardiometabolic pregnancy outcomes. To ensure consistency and comparability of the statistical approach in the two nationwide cohorts, the Swiss and Danish teams will maintain regular correspondence and hold online coordination meetings

Furthermore, to strengthen interoperability between exposure modelling and health datasets, a 3–4-month research exchange of PhD student Eric Twomey to **DCS** is currently under active planning. This exchange will facilitate effective linkage of modelled PNC) to residential coordinates within the Danish National Cohort. Additional funding for this exchange will be sought through the Swiss National Science Foundation Doc.Mobility scheme. During his stay, the PhD student may also explore UFP in a multi-pollutant framework with respect to central nervous system tumours in Denmark.

For WP6, WP18 and WP19, it is anticipated that the annual long-term UFP models from **Cyprus Institute** will provide an important input for European-wide Health Impact Assessment.

For the development of the integrated pollution-disease tool in WP13, extensive collaborations between **Luxembourg Institute of Health (LIH)**, **UMC-Mainz**, **VMU** and **Swiss TPH** are anticipated, as well as contributions to the analysis in WP17 and WP20 to understand scientific knowledge transfer and science to policy-practice integration, led by **UMC-Mainz** and **Julius Maximilians Universität Würzburg (JMU)**.

Similarly, contributions to communication and visibility for the project will be coordinated with **concentris** and the PI at **UMC-Mainz**. Similarly, cluster activities, especially with regard to environmental joint policy briefs and strategies for the cluster are anticipated and will be coordinated.

2.1.6 Luxembourg Institute of Health

The **Luxembourg Institute of Health (LIH)** has collected from partners of the consortium multiple datasets of previously generated datasets (both published and unpublished), which comprehend RNA sequencing, proteomics and metabolomics information about exposure of particulate matter, aircraft noise (and the combined exposure of the latter two) in murine models.

LIH has then integrated the aforementioned datasets (where possible), to conduct a meta-analysis study whose aim is to highlight genes and pathways that are consistently detected as statistically dysregulated in multiple independent studies. Such markers have been grouped and are currently being used by other partners to guide their decision in the selection of a panel of antibodies to use in future experiments.

LIH and **SDU** are closely collaborating on the generation, analysis and interpretation of proteomics data coming from murine tissue (produced by UMC-Mainz). So far three datasets have been produced:

- P01: 3 day exposure to particulate matter, aircraft noise and combined exposure in brain, heart and lungs.
- P02: 3 day exposure to micro and nano particles, in brain, heart and lungs.
- P03: longitudinal exposure (4 days, 1 week, 2 weeks, 4 weeks) to aircraft noise in brain.

P01 and P02 are currently being used to draft a joint manuscript (at least 3 partners) that will be submitted for publication within the first quarter of next year. Another joint manuscript on adverse outcome pathways (AOPs according to the OECD approach) for particulate matter exposures is currently prepared by **LIH** and already circulated among the partners.

LIH set up a secure online repository to enable data sharing amongst the partners of the consortium. In addition, FTP SSH connection was set up to enable secure and fast transfer of heavy data.

2.1.7 Vytautas Magnus University

VMU collaborates with the partner **SWISS-TPH**, to harmonize the environmental exposure methodology, suggested to use mobile laboratory for simultaneously underground monitoring of UFP, PM_{2.5}, NO₂, BC, and first round air pollution monitoring in Switzerland and Lithuania was completed.

VMU shared protocols with **SWISS-TPH**, **DCS**, **MFUB** and **VINS** for harmonizing activities and protocols of human epidemiological studies to investigate complex air and noise pollution-disease associations in susceptible groups. Presented formalized questionnaires, including health outcomes, sociodemographic variables, residential history, health behavior.

UMC-Mainz shared first results of preclinical models with **VMU**, focusing on UFP and noise effects on biomarkers of oxidative DNA damage and oxidative stress, potential for clinical studies.

LIH and **SDU** harmonized SOP for blood bio sample collection and data handling, and shared these SOPs with **VMU**. It comprises blood sampling, processing, and storing in clinical studies for human omics, metabolomics and proteomics analyses.

VMU helps **JMU**, for assessment of science-policy interfaces in environmental health risk management, elaborated and shared questionnaires to obtain socio-political data from partners for comparative pollution policy analyses. Data includes expert interviews with key stakeholders in pollution research and policy.

2.1.8 University of Belgrade, Medical Faculty & Vinča Institute of Nuclear Sciences

Regarding work package 4, **MFUB** shared the protocol for the clinical study NOXYCARD investigating short-term noise exposure on blood pressure, cardiovascular parameters and biomarkers in healthy persons with normal blood pressure. **MFUB** also shared the questionnaire for the study, including socio-demographic variables, general health, lifestyle habits, noise annoyance and noise sensitivity questionnaires, residential characteristics, self-assessed environmental and occupational noise exposure, self-reported access to green areas, perceived environmental pollution, etc. **MFUB and VINS** shared the protocol for human saliva sampling for the assessment of markers of oxidative stress and inflammation before and during the experimental noise exposure.

Regarding work package 9, **MFUB** shared the protocol for the clinical study NOXYCARD investigating short-term noise exposure on blood pressure, cardiovascular parameters and biomarkers in healthy persons with normal blood pressure. **MFUB and VINS** adopted the SOPs shared by **LIH and SDU** blood human blood and plasma collection and data handling. It comprises blood sampling, processing, and storing in clinical studies for human omics, metabolomics and proteomics analyses.

MFUB harmonized its questionnaire for this work package with **LIH and SDU** to include the additional data such as detailed personal medical history, medication and supplement use, dietary habits, etc. **VINS** is about to sign the DTA and MTA agreements with the respective sample recipients so that the data collection can start soon.

2.1.9 University of Eastern Finland

The University of Eastern Finland (UEF) and **UMC-Mainz** jointly conduct noise and particulate-matter exposure studies by sharing resources and expertise, including SOPs, audio files, mouse plasma and brain tissue, aorta tissues and generated data. They coordinate communication through regular updates and meetings, and they actively plan experiments, exchange research data for reporting and interpret the results together.

UEF and UNIPD share mouse heart tissues and SOPs and jointly generate data. They maintain communication through coordinated updates and meetings, and they jointly plan experiments, exchange research data and interpret the findings.

UEF and MUSC share mouse heart tissues and SOPs and collaborate in generating data. They ensure steady communication via updates and meetings, and they jointly plan experiments, share research data and interpret outcomes.

UEF and MPIC share naïve and modified pollen recombinant proteins and generate data together. They coordinate communication through updates, meetings and exchanges, and they jointly plan experiments, share research data and interpret the results.

UEF and LNS share SOPs, mouse tissues and co-generated data, maintaining communication through regular updates and meetings. They collaboratively plan experiments, exchange research data and interpret findings.

UEF and LIH share SOPs and archived omics datasets from previous projects involving UFP-exposed mouse brains. They communicate through coordinated updates and meetings, and they collaborate in planning experiments, sharing research data and interpreting results.

UEF and SDU share SOPs, mouse tissues and jointly generate data. They coordinate updates and meetings to maintain communication, and they jointly plan experiments, exchange research data and interpret outcomes.

UEF and **UMC-Mainz** also collaborate in an additional workflow in which they share SOPs, mouse tissues and generated data. They coordinate communication through updates and meetings, and they jointly plan experiments, share research data and interpret the results.

2.1.10 University of Padua

University of Padua (UNIPD) hosted a visit from Marin Kuntic of the **UMC-Mainz** from 2-5 December 2025 to install and configure the newly acquired noise-exposure system.

UNIPD is about to receive heart tissue from mice exposed to aircraft noise, ultrafine particles (UFP) or combined noise+UFP from the **UEF**. The team assesses these samples for histological alterations, oxidative modifications and markers of the brain–heart axis, including MAO-A, MAO-B, TrkB and BDNF.

UNIPD will receive lung, heart and brain-cortex samples from recent animal studies at **UMC-Mainz**.

2.1.11 Laboratoire National de Santé

Laboratoire National de Santé (LNS) has not yet started analysing samples but is now preparing to begin. The team is about to receive material from partner institutions to conduct oxidative-stress analyses (GSH/GSSG) in the following sample types:

- They will analyse human blood samples provided by **VMU** and **VINS**.
- They will also analyse tissue samples from **UMC-Mainz** and **UEF**.

2.1.12 Medical University of South Carolina

MUSC has been hosting a PhD student from the **UMC-Mainz** from 2-5 December 2025 to install and optimise the newly purchased noise-exposure system. The team is also intensively expanding mouse breeding to ensure that all animals can be exposed within a short timeframe upon setup of the noise exposure model in collaboration with **UMC-Mainz**.

MUSC will also receive samples from noise- and particle-exposed mice from **UMC-Mainz** to assess the presence of oligomeric deposits.

2.1.13 Julius-Maximilians University Würzburg

Julius-Maximilians University of Würzburg (JMU) is reporting about and planning the following collaborations within the consortium:

- **Identifying boundary spanners for environmental health:**
All project partners were asked to complete a questionnaire developed by **concentris** and Ulrike Zeigermann (**JMU**), focusing on key stakeholders in their respective research fields and countries. These data are currently being analysed to obtain a systematic understanding of the stakeholder landscape and to identify, as an initial step, potential boundary spanners essential for effective knowledge transfer. Continuous exchanges with **all partners** will be maintained throughout 2026 to discuss interim findings, and the information already collected will be complemented through additional interviews.
- **Survey research:**
Support can be provided to those project teams conducting surveys with probands involved in the medical studies. Opportunities may be explored to integrate additional

questions that offer insights into how participants perceive the health system, environmental conditions, and relevant scientific and political structures in their countries. For this purpose, the survey questionnaires should be shared with **JMU**.

- **Studying context factors in the partner countries:**

Regular exchanges with colleagues will be pursued to identify relevant contextual factors in the partner countries that should be considered when developing the framework for the Science-Policy-Practice Interface (SPPI). Their expertise can also be used to assess our findings derived from macro-data analyses and/or results from established social science survey programmes (e.g., World Values Survey, European Social Survey).

2.2 Joint publications

This chapter gives an overview about the joint publications from MARKOPOLO partner so far (until 31st December 2025):

Peer-reviewed original research papers and review articles:

- Münzel T, Kuntic M, Daiber A, Sørensen M. [Transportation noise and the cardiometabolic risk. Atherosclerosis](#). 2025 Apr;403:119148. doi: 10.1016/j.atherosclerosis.2025.119148. Epub 2025 Feb 24. PMID: 40055082.
- Münzel T, Kuntic M, Lelieveld J, Aschner M, Nieuwenhuijsen MJ, Landrigan PJ, Daiber A. [The links between soil and water pollution and cardiovascular disease. Atherosclerosis](#). 2025 Apr;403:119160. doi: 10.1016/j.atherosclerosis.2025.119160. Epub 2025 Mar 2. PMID: 40074641.
- Kuntic M, Kuntic I, Cleppien D, Pozzer A, Nußbaum D, Oelze M, Junglas T, Strohm L, Ubbens H, Daub S, Bayo Jimenez MT, Danckwardt S, Berkemeier T, Hahad O, Kohl M, Steven S, Stroh A, Lelieveld J, Münzel T, Daiber A. [Differential inflammation, oxidative stress and cardiovascular damage markers of nano- and micro-particle exposure in mice: Implications for human disease burden](#). Redox Biol. 2025 Jun;83:103644. doi: 10.1016/j.redox.2025.103644. Epub 2025 Apr 22. PMID: 40319735
- Münzel T, Sørensen M, Lelieveld J, Landrigan PJ, Kuntic M, Nieuwenhuijsen M, Miller MR, Schneider A, Daiber A. [A comprehensive review/expert statement on environmental risk factors of cardiovascular disease](#). Cardiovasc Res. 2025 Sep 29;121(11):1653-1678. doi: 10.1093/cvr/cvaf119. PMID: 40795898
- Münzel T, Kuntic M, Daiber A, Sørensen M. [Transportation Noise and Cardiovascular Health: Evidence, Mechanisms, and Policy Imperatives](#). Anatol J Cardiol. 2025 Sep 8;29(10):525–32. doi: 10.14744/AnatolJCardiol.2025.5755. Epub ahead of print. PMID: 40919830
- Münzel T, Kuntic M, Molitor M, Sørensen M, Daiber A. [Transportation noise pollution as a cardiovascular risk factor: From epidemiological evidence to mechanistic insights](#). EXCLI Journal 2025;24:1713-1739 – ISSN 1611-2156. 2025 doi: <https://doi.org/10.17179/excli2025-9050>
- Georgiades P, Kohl M, Nicolaou MA, Christoudias T, Pozzer A, Dovrolis C, Lelieveld J. [Global high-resolution ultrafine particle number concentrations through data fusion with machine learning](#). Sci Data. 2025 Nov 14;12(1):1790. doi: 10.1038/s41597-025-06055-9.

Commentaries and Editorials and Book Chapters:

- Commentary: Hahad O, Keller K, Lelieveld J. [Physical activity and polluted air: implications for COPD prevention and policy](#) - Lancet Reg Health West Pac. 2025 Sep 18;62:101693.
doi: 10.1016/j.lanwpc.2025.101693.
- Münzel T, Kuntic M, Daiber A. [Prenatal Pollution and Programmed Hypertension: Nrf-2/NLRP3 at the Crossroads](#). Hypertension. 2025 Nov;82(11):1841-1843.
doi: 10.1161/HYPERTENSIONAHA.125.25912. Epub 2025 Oct 15.

Publications by only one MARKOPOLO partner but mentioning support:

- Daiber A, Rajagopalan S, Kuntic M, Münzel T. [Cardiovascular risk posed by the exposome](#). Atherosclerosis. 2025 Jun;405:119222.
doi: 10.1016/j.atherosclerosis.2025.119222. Epub 2025 Apr 30. PMID: 40339362
- Münzel T, Daiber A. Health Effects of Wildfires. Dtsch Med Wochenschr. 2025 Jun;150(13):772-779.
doi: 10.1055/a-2542-8711. Epub 2025 May 28.
- Kelters IR, Koop Y, Young ME, Daiber A, van Laake LW. [Circadian rhythms in cardiovascular disease](#). Eur Heart J. 2025 Sep 22;46(36):3532-3545.
doi: 10.1093/eurheartj/ehaf367. PMID: 40663373; PMCID: PMC12450527.
- Mihalikova D, Strohm L, Czarnowski A, Ubbens H, Grund Z, Molitor M, Oelze M, Kuntic M, Gericke A, Lurz P, Munzel T, Daiber A, Jansen T and Stamm P. [The Impact of Aircraft Noise Exposure on the Efficacy of Empagliflozin Therapy in an Animal Model of Obesity](#). Diabetes & Obesity International Journal 10 (3)
DOI: 10.23880/doi-16000299
- Arijan Valar, Jiayin Zheng, Thomas Münzel, Andreas Daiber and Marin Kuntic. [Impact of noise and air pollution on the cardiovascular system through the brain–heart axis](#). Redox Experimental Medicine (2025) 2025 e250004
DOI: <https://doi.org/10.1530/REM-25-0004>

3 EXPOHEALTHNET RESEARCH CLUSTER

3.1 About the cluster and its mission



ExpoHealthNet is a collaborative cluster on the role of environmental pollution in non-communicable diseases: air, noise and light and hazardous waste pollution.

To maximise synergies, avoid duplication of efforts, and enhance scientific and societal impact, seven Horizon Europe projects have joined forces under this initiative. ExpoHealthNet brings together leading research teams to investigate how environmental stressors contribute to conditions such as respiratory, cardiovascular, metabolic, and immune-mediated diseases. Through close collaboration and knowledge exchange, the cluster aims to generate actionable evidence and inform effective policies to mitigate the health impacts of pollution and climate change.

ExpoHealthNet Website: <https://expohealthnet.eu/>

3.2 Cluster working groups

The ExpoHealthNet cluster has shared its collaborative work into three working groups:

- **Working Group 1: Science Translation for Policy and Practice**
- **Working Group 2: Data analysis/management and protection**
- **Working Group 3: Communication and Dissemination**

3.2.1 Working Group 1: Science Translation for Policy and Practice

Working Group (WG) 1 focuses on translating the scientific findings from the seven ExpoHealthNet projects into actionable insights for policymakers and public health stakeholders. Led by the MARKOPOLO and ENACT projects, this working group plays a central role in ensuring that cutting-edge environmental health research is effectively channelled into policy strategies to reduce the burden of non-communicable diseases across Europe.

WG1 objectives:

- Ensure alignment of scientific outputs with policy needs
- Foster dialogue between researchers and decision-makers
- Develop strategies for science-to-policy translation
- Support evidence-informed environmental health policies

More information on WG1: <https://expohealthnet.eu/policy-and-practice/>

3.2.2 Working Group 2: Data analysis/management and protection

Working Group (WG) 2 ensures robust, secure and FAIR-aligned data management practices across the ExpoHealthNet cluster. Led by the ENVESOME and UPRISE projects, this working group facilitates interoperability, harmonisation and responsible reuse of data generated by the seven projects. WG2 plays a key role in ensuring that environmental health data can be integrated, analysed and leveraged for maximum scientific and societal impact.

WG2 objectives:

- Ensure all data follows FAIR (Findable, Accessible, Interoperable, Reusable) principles
- Promote harmonised data standards and ontologies across projects
- Guide data protection and privacy compliance (GDPR)
- Develop joint approaches for data sharing, storage and reuse

More information on WG2: <https://expohealthnet.eu/data-and-protection/>

3.2.3 Working Group 3: Communication and Dissemination

WG3 is responsible for shaping a unified voice and brand for the ExpoHealthNet cluster. Led by the EXPOSIM, ClimAir and ExpoSignalz projects, the group coordinates joint communication and dissemination activities that enhance the visibility, reach and impact of the cluster's research. WG3 ensures that project results are accessible to diverse audiences, from policymakers and researchers to civil society and the general public.

WG3 objectives:

- Create a coherent and recognisable cluster identity
- Develop and implement a joint communication and dissemination strategy
- Promote transparency, engagement and knowledge sharing through dedicated activities (newsletters, brochure, workshops, etc.)
- Support all projects in amplifying their results across channels and stakeholder groups

More information on WG3: <https://expohealthnet.eu/communication-and-dissemination/>

3.3 Cluster partners



- ClimAir – Climate change and air contamination
- ENACT – Environmental effect on health care and wellbeing and active interventions
- ExpoSignalz – Dissecting brain pollutant exposure & its contribution to neurodegeneration and Alzheimer's disease
- ENVESOME – The environmental exposome and health
- EXPOSIM – Environmental stressors as causal determinants for immune-mediated diseases

- MARKOPOLO – Noise and/or ultrafine particulate matter induced cerebral and cardiovascular damage
- UPRISE – Unravelling ultrafine particulate matter and micro nano plastic's mechanisms of impact on fetal health

More information about the cluster projects: <https://expohealthnet.eu/projects/>

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