

COUPH (Copenhagen Ultrafine Particles and Health)

Heresh Amini¹, Marie L. Bergmann¹, Seyed Mahmood Taghavi Shahri¹, Youn-Hee Lim¹, Jules Kerckhoffs², Jibrán Khan^{3,4}, Tom Cole-Hunter¹, Laust H. Mortensen^{1,5}, Shali Tayebi¹, Theis Lange¹, Esben Budtz-Jørgensen¹, Ole Hertel⁶, Rasmus Reeh⁷, Christian Gaarde Nielsen⁷, Kees de Hoogh^{8,9}, Jie Chen², Gerard Hoek², Bert Brunekreef², Kees Meliefste², Rudi Westendorp¹, Steffen Loft¹, Joel Schwartz¹⁰, Roel Vermeulen², Zorana J. Andersen¹

¹Department of Public Health, University of Copenhagen, Copenhagen, Denmark; ²Institute for Risk Assessment Sciences (IRAS), Utrecht University, The Netherlands; ³Department of Environmental Science, Aarhus University, Aarhus, Denmark; ⁴Danish Big Data Centre for Environment and Health (BERTHA), Aarhus University, Roskilde, Denmark; ⁵Statistics Denmark, Copenhagen, Denmark; ⁶Department of Ecoscience, Aarhus University Denmark; ⁷City of Copenhagen and Copenhagen Solution Lab, Copenhagen, Denmark; ⁸Swiss Tropical and Public Health Institute, Basel, Switzerland; ⁹University of Basel, Basel, Switzerland; ¹⁰Harvard TH Chan School of Public Health, Boston, United States

Background

To date, sparse epidemiological evidence suggests associations of ultrafine particles (particulate matter with diameter < 0.1 μm ; UFPs) with cardiovascular disease (CVD) yet no studies adjusted for road traffic noise.

There is lack of studies on long-term exposure to UFPs and all- and cause-specific mortality and morbidity due to dementia, diabetes, and respiratory diseases (RD), all of which have been linked so far to long-term exposure to particulate matter $\leq 2.5 \mu\text{m}$ (PM_{2.5}).

Objectives

Main objective: To examine the association between long-term exposure to UFPs and mortality and morbidity due to major cardio- and cerebrovascular, respiratory, metabolic, and neurodegenerative diseases

Specific objective 1: To validate Google Air View-based model predictions for UFPs.

Specific objective 2: To determine if long-term exposure to UFPs is associated with total natural and cause-specific mortality (due to cardiovascular disease (CVD), respiratory disease (RD), diabetes, and dementia), independently of particular particulate matter of diameter < 2.5 μm (PM_{2.5}), nitrogen dioxide (NO₂), black carbon (BC), and road traffic noise.

Specific objective 3: To determine if long-term exposure to UFPs is associated with incidence of CVD, chronic RD (including lung cancer), diabetes, and dementia, independently of PM_{2.5}, NO₂, BC, and road traffic noise.

Methods

Population: People 30 years or older who were residing in Copenhagen, Frederiksberg, and Tårnby municipalities on January 01, 2010 (~400,000).

Exposure: Long-term estimates of UFPs (Figure 1), nitrogen dioxide (NO₂), and black carbon (BC) from Google Air View-based land use regression models.

Health outcomes: Total natural and cause-specific mortality and morbidity due to CVD (myocardial infarction, heart failure, atrial fibrillation, and stroke), RD (asthma, COPD, and lung cancer), diabetes, and dementia.

Confounding covariates: Individual-level data on SES related variables in year 2010. Other air pollutants (PM_{2.5}, NO₂, and BC) from the European-wide hybrid ELAPSE LUR models, and road traffic noise from NORD2000 model.

Statistical analyses: Cox proportional hazard models, and Bayesian kernel machine regression (BKMR).

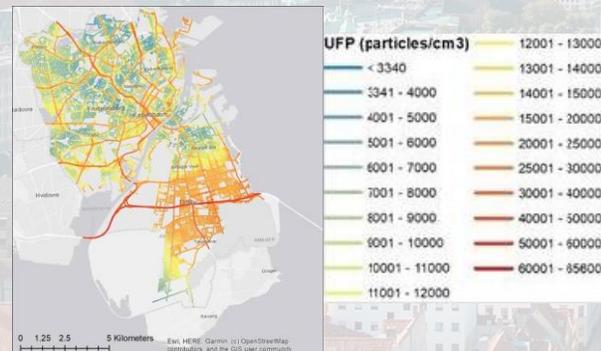


Figure 1. Predicted UFP from LUR

Preliminary results

External validation of Google model

- Completed UFP measurement for one year at reference site located at University of Copenhagen campus using a DiSCmini (Testo SE & Co., Germany)
- Completed two measurement campaigns (one in the colder season and one in the warmer season) at 37 volunteer locations (Figure 2), and calculated the annual mean at each site adjusted for temporal variability.
- Correlation was -0.03 for validation sites vs Google LUR for UFP (Figure 3).

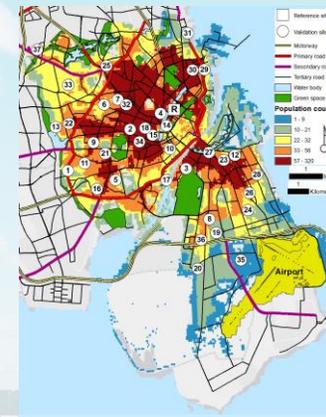


Figure 2. Location of validation study sites

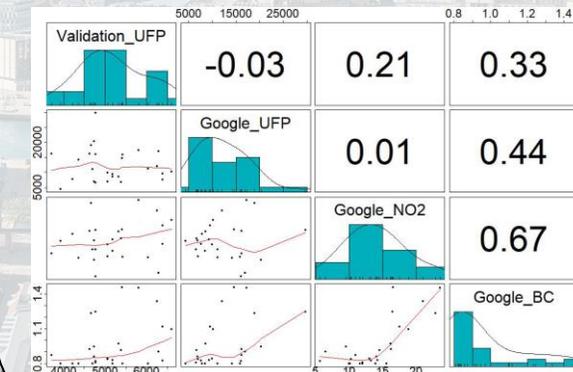


Figure 3. The correlation of validation study UFP with Google LUR data.

Preliminary results

Cohort creation

The summary of COUPH population is tabulated in Table 1.

Table 1. The number of people living in the COUPH area by municipality with age group of 30 years and higher on 01 January 2010

	Males	Females	Total
Copenhagen	150,831 (49.8%)	151,982 (51.2%)	302,813 (77.4%)
Frederiksberg	28,386 (46.4%)	32,800 (53.6%)	61,186 (15.6%)
Tårnby	12,874 (47.4%)	14,284 (52.6%)	27,158 (6.9%)
Total	192,091 (49.1%)	199,066 (50.9%)	391,157 (100.0%)

Exposure merge with population

The Google LUR polyline data is transformed to gridded data with 15 m cell size using natural neighbor (Sibson) method. We are currently in the process of merging the exposure data with COUPH population.

Discussion

COUPH will use unique data and advanced methods to provide novel exposure-response functions for the effects of long-term exposure to UFPs, and will be useful in evaluation of a need of regulating UFPs.