



Meeting finale del Progetto BIGEPI
24 Marzo 2023

L'esposoma: la nuova sfida per la valutazione degli effetti dell'inquinamento sulla salute

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Disclosures

International

- ERS Ethics and Integrity Committee (Member)
- EAACI ROC
- EAACI Environmental Guidelines
- AAAAI Environmental Exposures and Respiratory Health Committee
- ATS Health Policy Committee

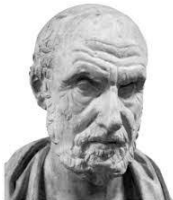
National

- IRD Ethics Committee (President)
- Comité prévention et protection (CPP) MEDD
- SFA Scientific Committee (Member)
- CSTB Scientific Committee (Member)
- RNSA Scientific Committee (Member)
- Météo France (Commission Santé)
- Société de Pneumologie de Langue Française: GT PAPPEI
- Conseil d'Administration de l'APPA

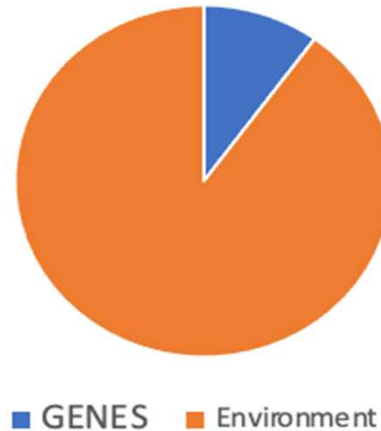
Section Editor for Environmental Health of ERJ (IF: 33) and IJTLD (IF:4)

Major role of the environment...

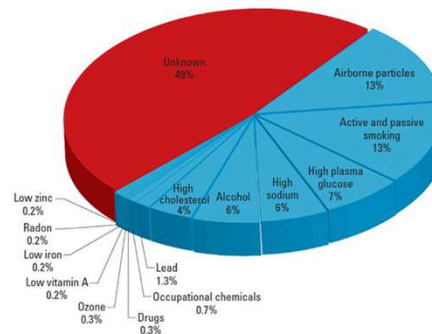
Hippocrates wrote in his treatise "Airs, waters, places": "To deepen medicine, we must first consider the seasons, know the quality of water, winds, study the various conditions of the soil and the way of life of the inhabitants "



Hippocrates, 400 BC



Risk factors for exposures that contribute to chronic-disease mortality
Rappaport et al., EHP, 2014



✓ Environment more important than genetics (explains 70-90% of diseases).

✓ Known exposures are few (air pollution, smoking, nutrition, alcohol, lead...)

The Allergy and Asthma Pandemic

(Similar in many autoimmune diseases)



John Bostock published

1819 the first case

Charles Blackley

1873 the first

28 cases of hayfever / hay asthma

1819

1900

1960

2010

Swiss army
1%

Swiss army
1-2%

Swiss army
20%



Aberg et al.
Swedish army

1971
4.4%

1981
8.4%



UK
43%

USA
26%

2016 Medall
>55% allergen
sensitization
in Europe

After 2000s
Food allergy
EoE
Drug
hypersensitivity

More than 350'000 new
substances have been



Courtesy
Cezmi Adkis

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Chronic non-communicable diseases patients: 20-30 Million patients

Key facts

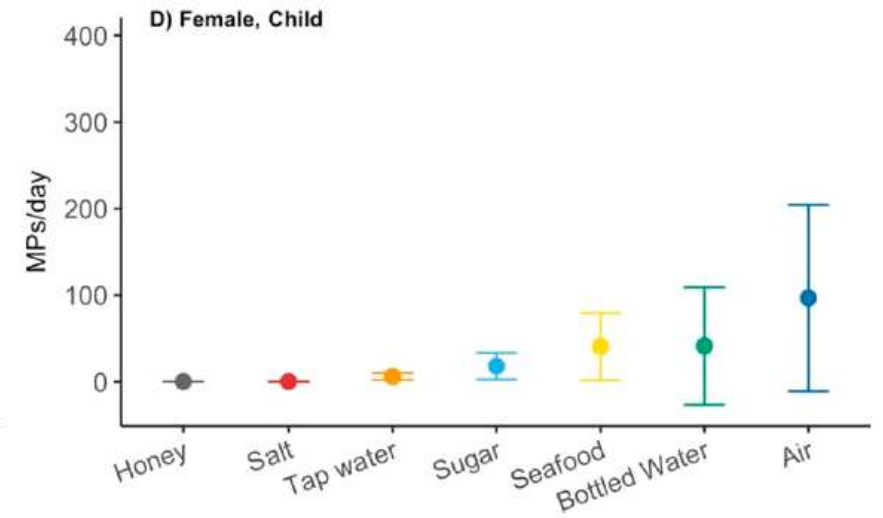
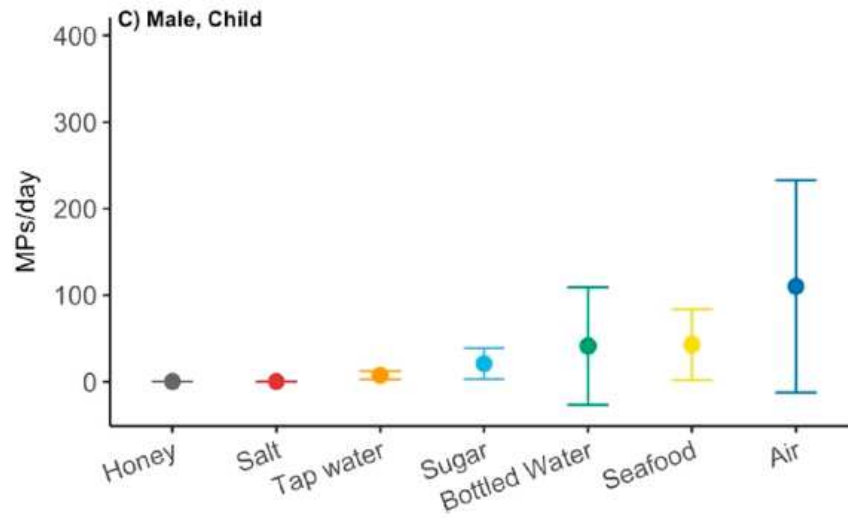
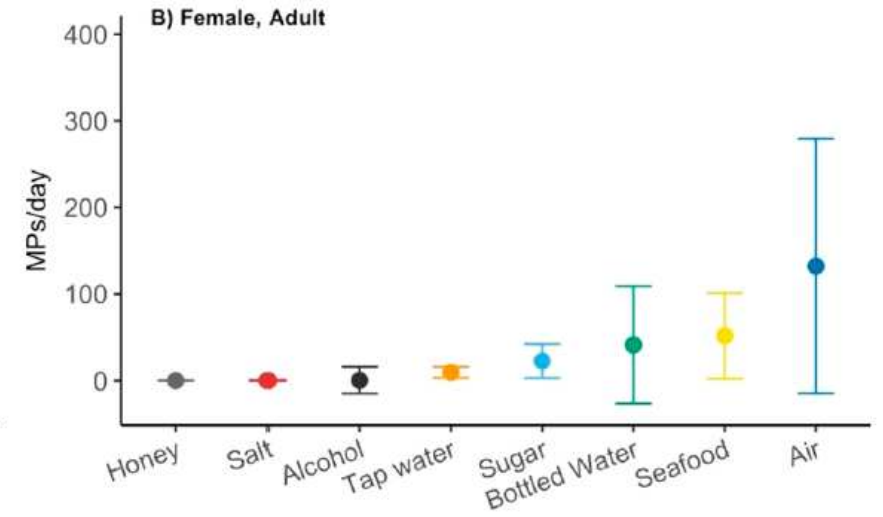
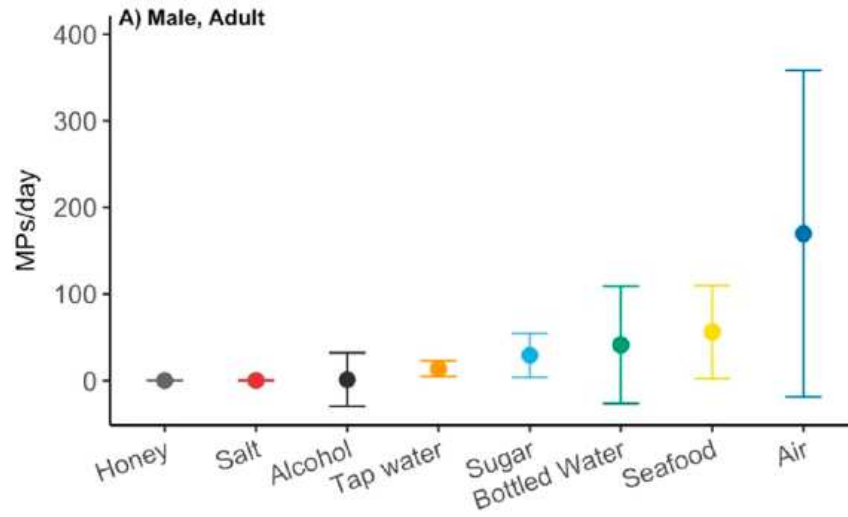
Since the 1960s

- More than 350000 new (*ex novo*) man-made substances have been produced → **NEW EMERGENT POLLUTANTS**
- New environmental conditions and lifestyle (→ Hps)

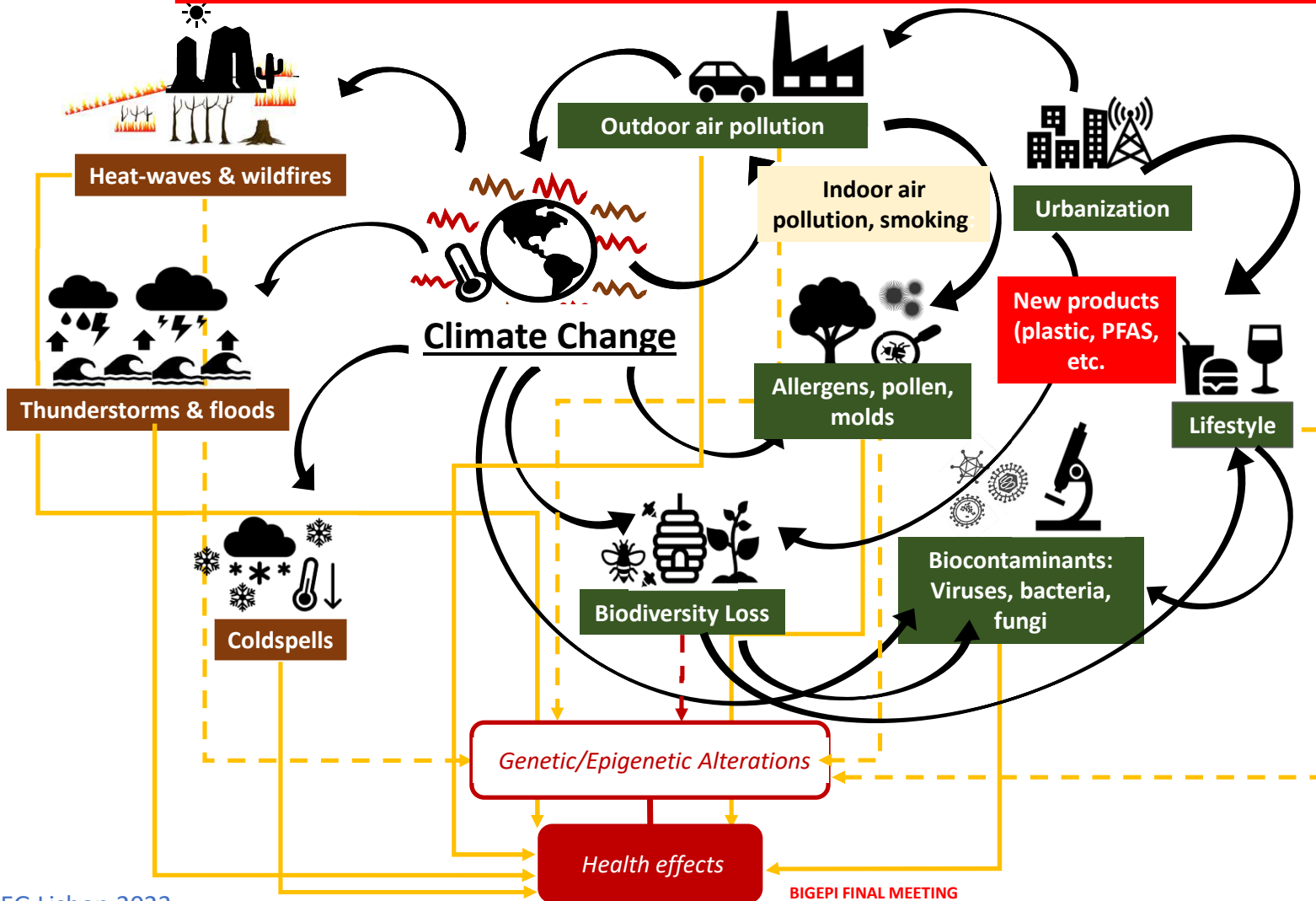
Since 2000

- A new wave of chronic inflammatory diseases, not only allergies but respiratory, metabolic, auto-immune disease grew into pandemic size → **2 billion patients**
- **Elevated socioeconomic burden**

Plastic (MP/d) in USA



AIR POLLUTION IS NOT AN ISOLATED FACTOR



- Chemical air pollution (old, new, emergent)
- Biocontaminants (allergens, pollen, molds, virus (COVID-19...))
- Outdoors/indoors
- Alone or in combination



The Exposome...

The exposome is the sum of all environmental exposures that an individual experiences from conception to death. This concept...

- Internal exposome
- External exposome (specific and nonspecific) (general)

It comprises

- processes of metabolism and DNA repair
- external exposures to physical agents, chemical contaminants, and biological agents
- social, economic, and psychological influences.

Wild, C. P. (2012). The exposome: from concept to utility. *International Journal of Epidemiology*, 41(1), 24–32.

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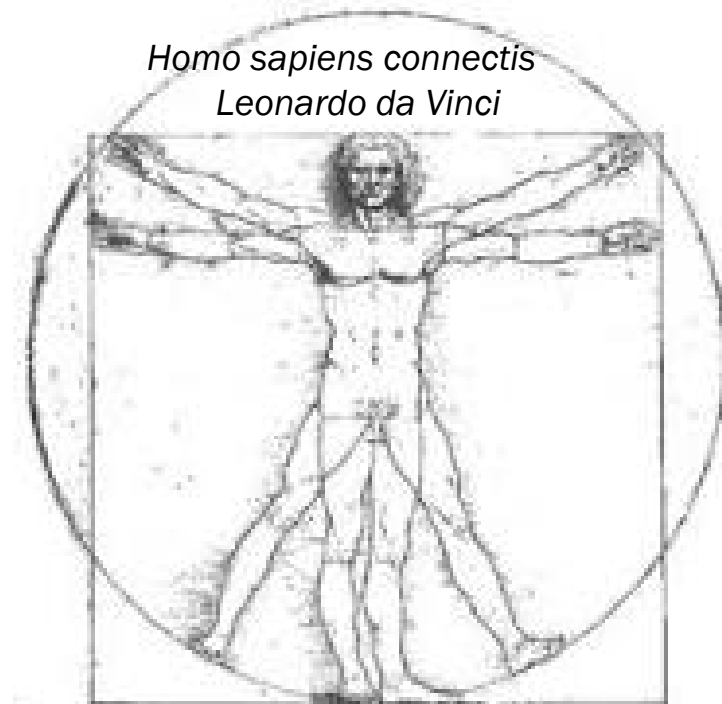
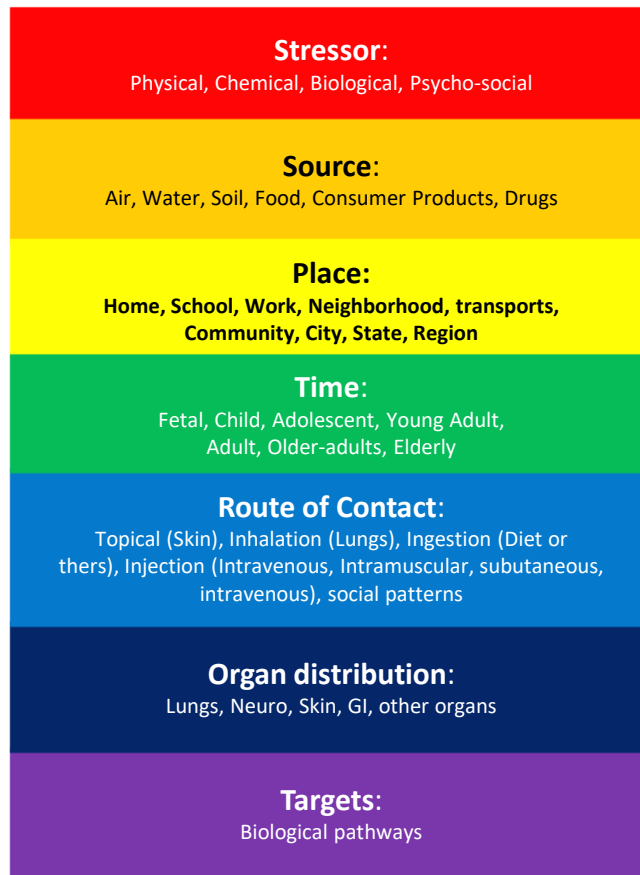


The Complexities of environmental exposure



LEAD:

Individuals are exposed to lead through air, water, soil, at home, work, during transportation, in early life, later ... Through different penetration route. This can target different organs... and uses different pathways.



Homo sapiens connectis
Leonardo da Vinci

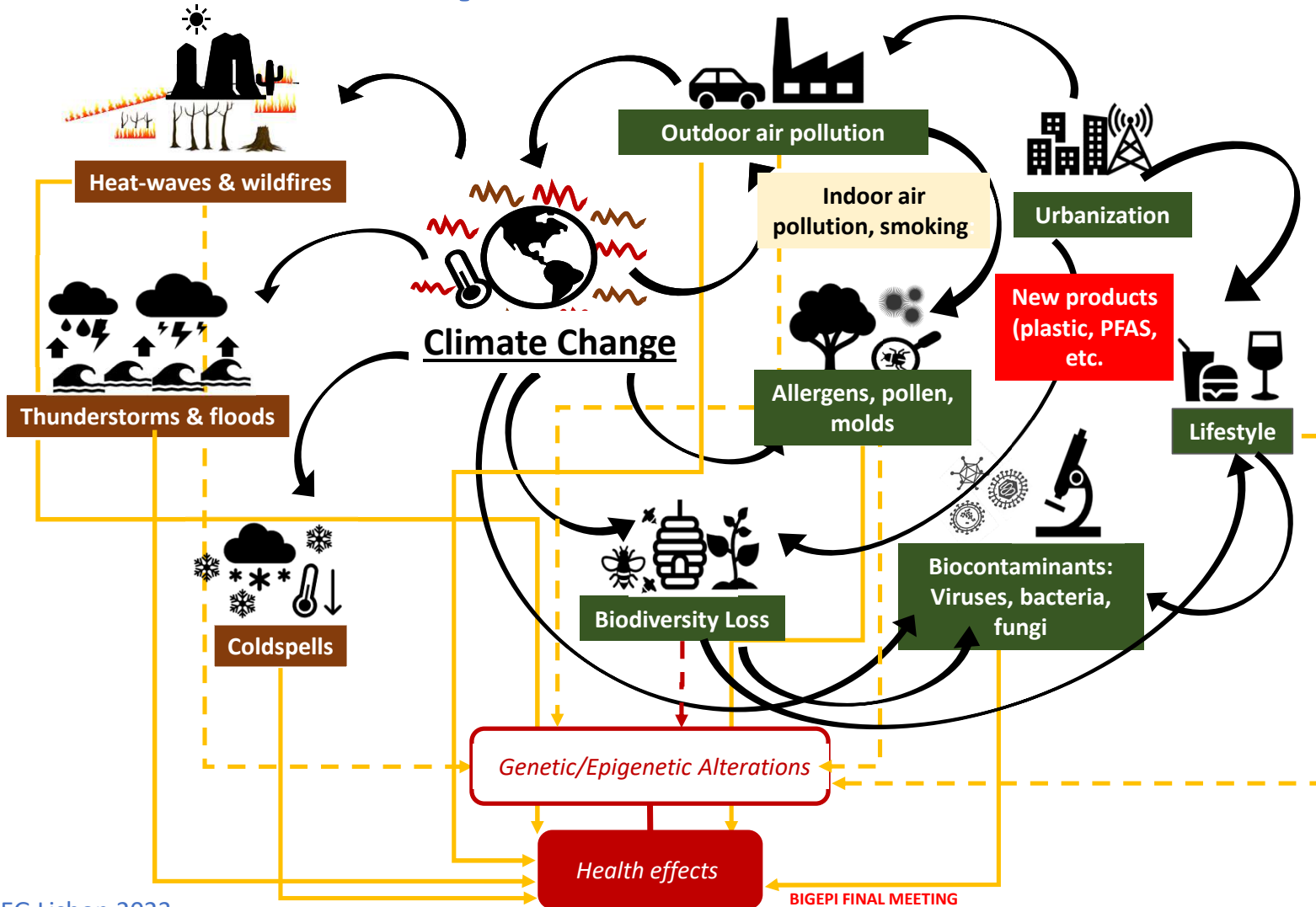
Health consequences of this complexity has to be taken into account to explain diseases

Hypothesis

**Increase in asthma: a more toxic environment or
a more susceptible population?**

Anthony Seaton, David J Godden, Katrina Brown

Asthma exposome increase due to climate change



More susceptible/vulnerable individuals

- *in utero* life
- Toddlers
- Children
- Patients
-

The double penalty



Children particularly at risk

Low socio-economic status (SES) impinges on respiratory health through greater exposure to air pollution, occupational agents, diet, housing conditions, impaired health access.

Unesco 2022

Household income, fetal size and birth weight: an analysis of eight populations

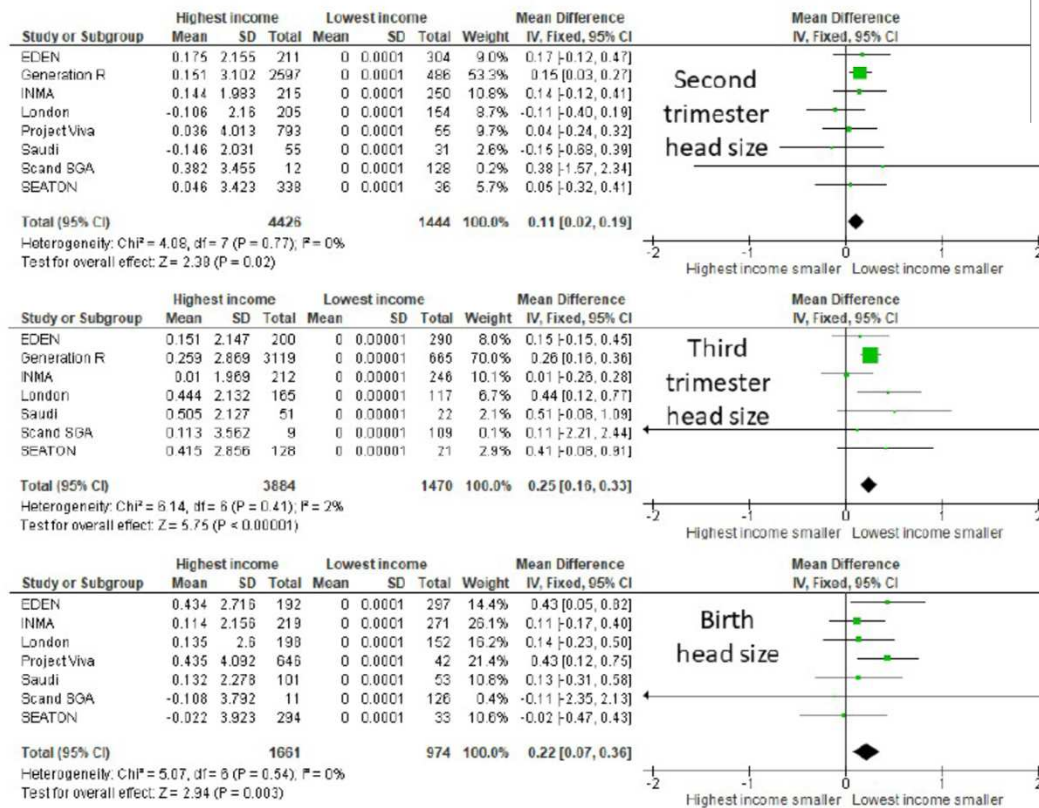
Steve Turner¹, Anke G Posthumus^{2,3}, Eric A P Steegers^{2,3}, Amel AlMakoshi^{1,4}, Bahauddin Sallout⁵, Sheryl L Rifas-Shiman⁶, Emily Oken⁶, Ben Kumwenda¹, Fatemah Alostad¹, Catherine Wright-Corker¹, Laura Watson¹, Diane Mak¹, Hiu Ching Cheung¹, Alice Judge¹, Lorna Aucott⁷, Vincent W V Jaddoe^{2,8}, Isabella Annesi Maesano⁹, Munawar Hussain Soomro⁹, Peter Hindmarsh¹⁰, Geir Jacobsen¹¹, Torstein Vik¹², Isolina Riaño-Galan^{12,13,14}, Ana Cristina Rodríguez-Dehli^{14,15,16}, Aitana Lertxundi^{14,17,18}, Loreto Santa Marina Rodríguez^{14,17,19}, Martine Vrijheid^{14,20,21}, Jordi Julvez^{22,23,24}, Ana Esplugues^{14,25}, Carmen Iñiguez^{14,26}

IJCH 2022)

WHAT THIS STUDY ADDS

- ⇒ Across eight different populations, we report an association between lower household income (HI) and reduced anthropometric measurements from the second trimester onwards.
- ⇒ The association was seen most clearly for fetal and neonatal head size, and was also present for weight but not length.
- ⇒ The magnitude of the association became greater as pregnancy progresses.

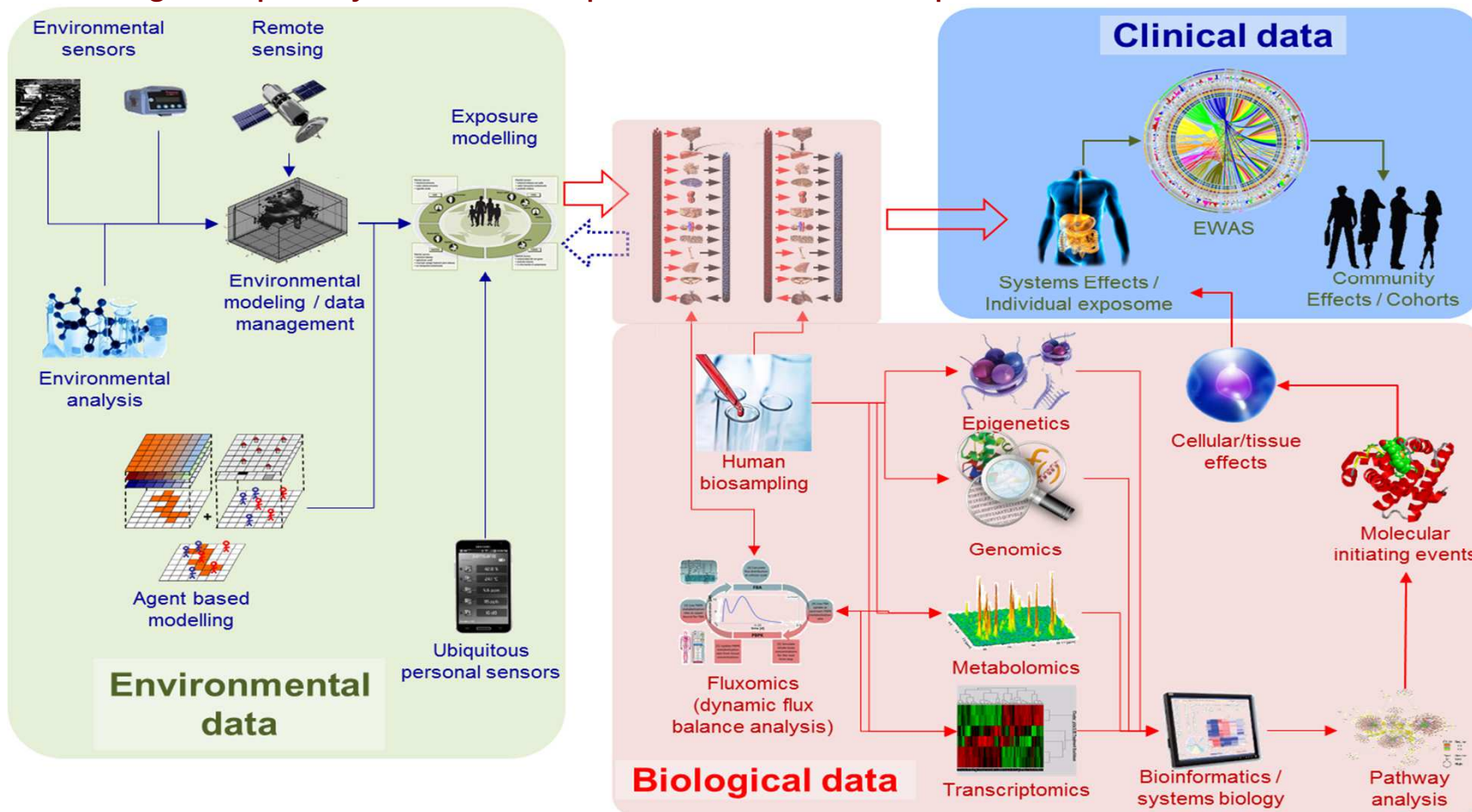
Original research



L'esposoma: la nuova sfida per la valutazione degli effetti dell'inquinamento sulla salute

HEALS The connectivity approach

Embracing complexity to seek simple solutions to EH problems



IAM

www.heals-eu.eu

Evidence levels of air pollution exposure assessment



Annesi-Maesano et al. Springer 2021

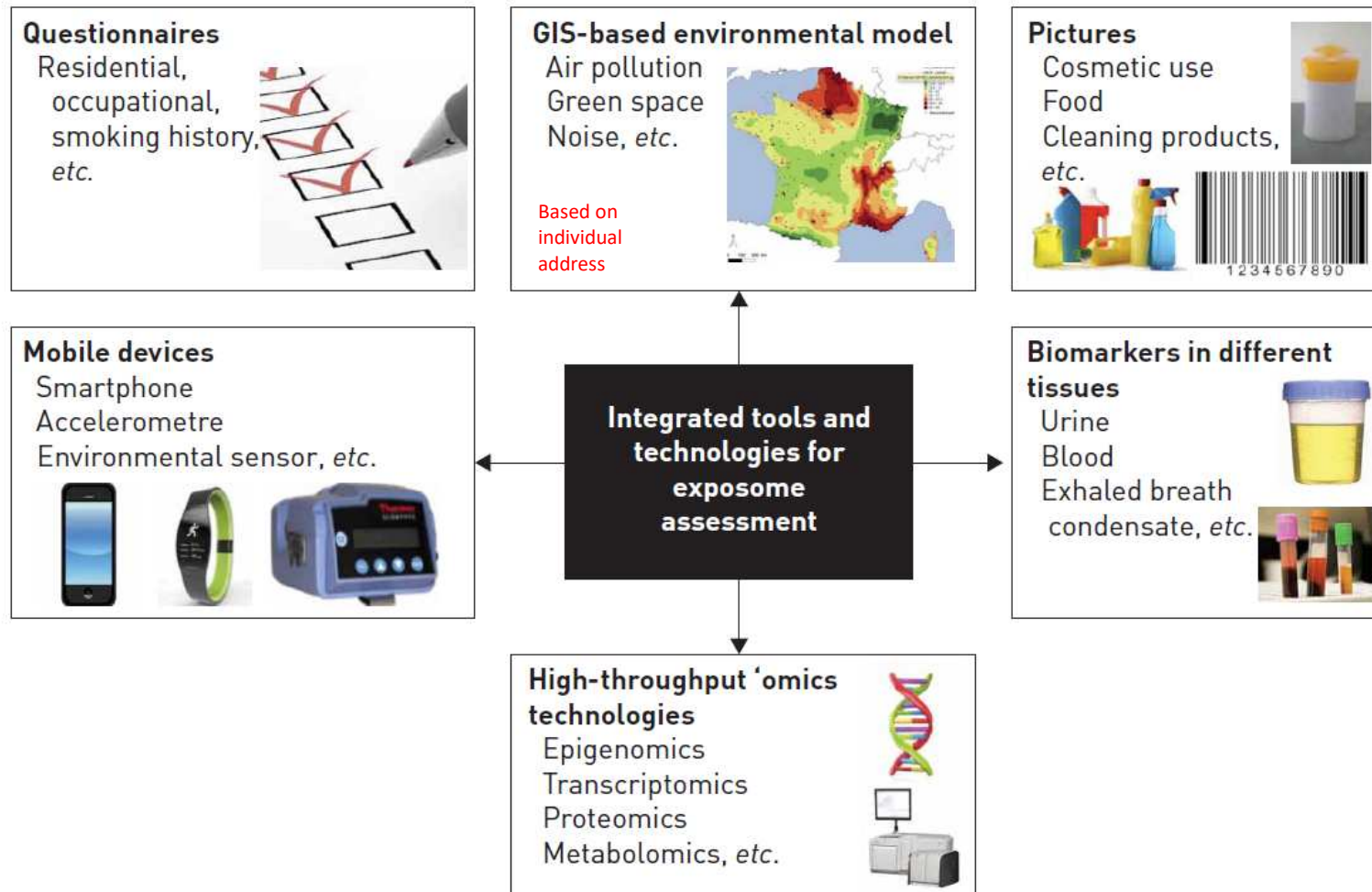
ECOLOGICAL ASSESSMENT OF EXPOSOME

Un sistema di gestione dei dati ambientali per la valutazione dell'esposoma esterno in dieci città europee

Ilaria Stanisci¹, Sofia Tagliaferro¹, Sara Maio¹, Federico Pirona¹, Giuseppe Sarno¹, Michael Kabesch², Marianthi Kermenidou, Nafsika Papaioannou, Reena Perchard, Igor Prpic, Kinga Polanska, Joanna Jerzynska, Elisabete Ramos, Joaquim Rovira, Jordina Belmonte Soler, Denis Sarigiannis, Janja Snoj Tratnik, Zdravko Spiric, Jacqueline Zickella, Salvatore Fasola, Stefania La Grutta, Velia Malizia, Laura Montalbano, Sandra Baldacci¹, Isabella Annesi-Maesano per i gruppi di studio EarlyFOOD e HEALS.

Risultati: Attraverso l'EDMS sono emerse differenze negli aspetti demografici e ambientali tra le città partecipanti ai due progetti. Reus risulta avere la più alta aspettativa di vita nelle donne, e Palermo negli uomini. Regno Unito presenta il tasso più elevato di obesità. Croazia e Polonia hanno il maggior consumo di farmaci (prescritti e non prescritti, rispettivamente), mentre Grecia e Portogallo hanno valori più elevati di fumatori (%) e consumo giornaliero di alcool, rispettivamente. Le città più inquinate da PM, NO₂, e O₃ sono Lodz, Porto e Fiume, rispettivamente. Salonicco, invece, è la città più urbanizzata. I quantitativi cumulati più alti di pollini risultano a Fiume. I livelli di rumore giornalieri e notturni più alti sono stati registrati a Reus (traffico) e a Ratisbona (ferrovia). Nelle acque potabili sono risultati valori elevati di Arsenico, Cromo, e Piombo rispettivamente a Salonicco, Porto, Parigi. Il paese con i più alti valori di residui di pesticidi negli alimenti è risultato essere il Portogallo.

INDIVIDUAL ASSESSMENT OF EXPOSOME



INDIVIDUAL ASSESSMENT OF EXPOSOME: AIR POLLUTION



Individual assessments in real-time of:

PM₁, PM_{2.5}, PM₁₀

VOCs

T

Hum

Pressure

GPS

G. Pau LIP6 SU

Isabella Annesi-Maesano, EPAR

IPLESP, INSERM et SU



A methodology for the characterization of portable sensors for air quality measure with the goal of deployment in citizen science

Baptiste Languille ^{a,*}, Valérie Gros ^a, Nicolas Bonnaire ^a, Clément Pommier ^a, Cécile Honoré ^{b,1},
Christophe Debert ^b, Laurent Gauvin ^b, Salim Srairi ^c, Isabella Annesi-Maesano ^d, Basile Chaix ^e,
Karine Zeitouni ^f

^a Laboratoire des Sciences du Climat et de l'Environnement CNRS-CEA-UVSQ, IPSL, Gif-Sur-Yvette, France

^b Airparif, Paris, France

^c CEREMA, Trappes-en-Yvelines, France

^d EPAR, IPLESP, INSERM et Sorbonne Université, Faculté de Médecine Saint-Antoine, Paris, France

^e INSERM, Sorbonne Université, Institut Pierre Louis d'Epidémiologie et de Santé Publique IPLESP, Nemesis team, Paris, France

^f Université de Versailles Saint-Quentin, Versailles, France

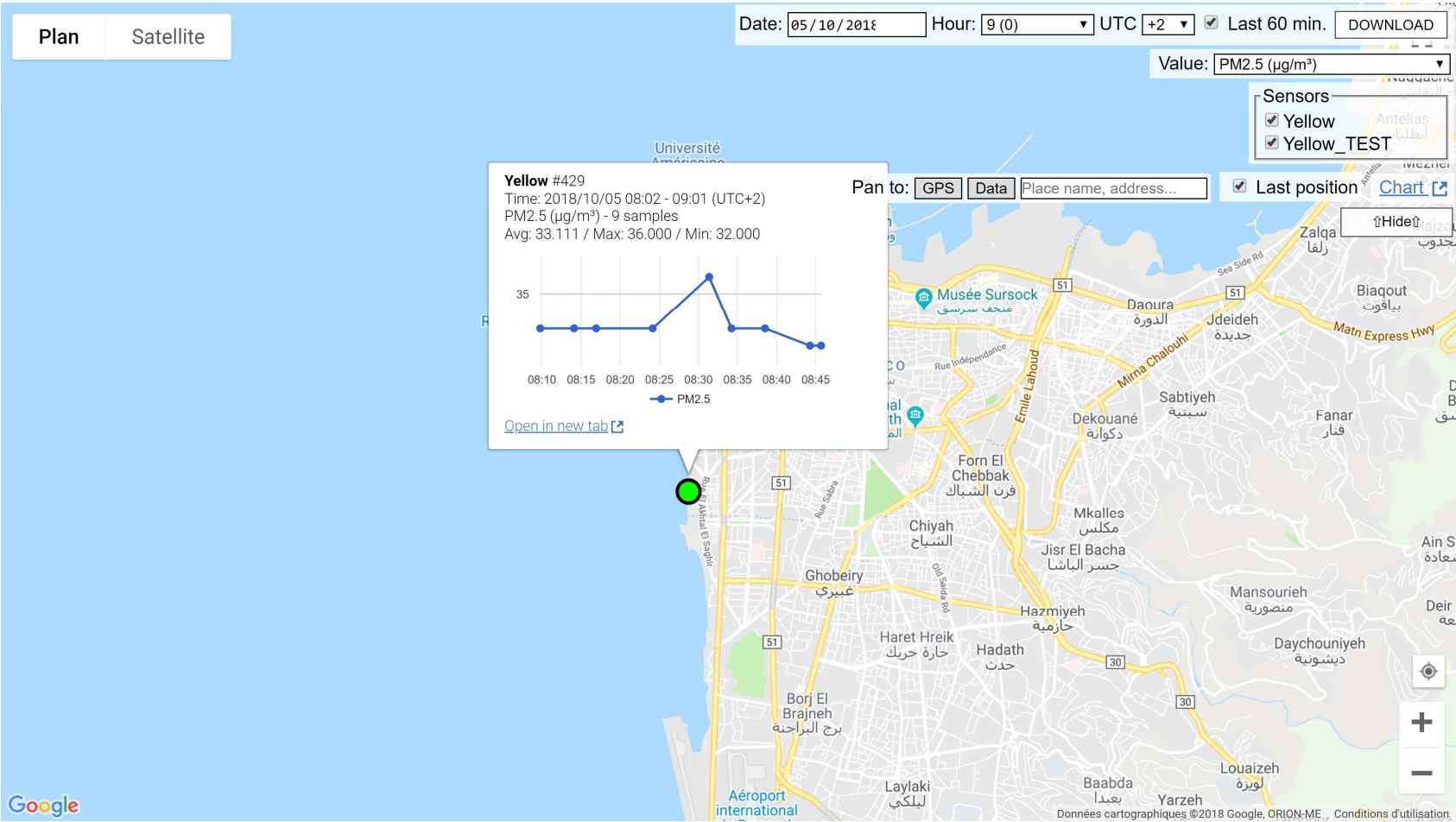


Article

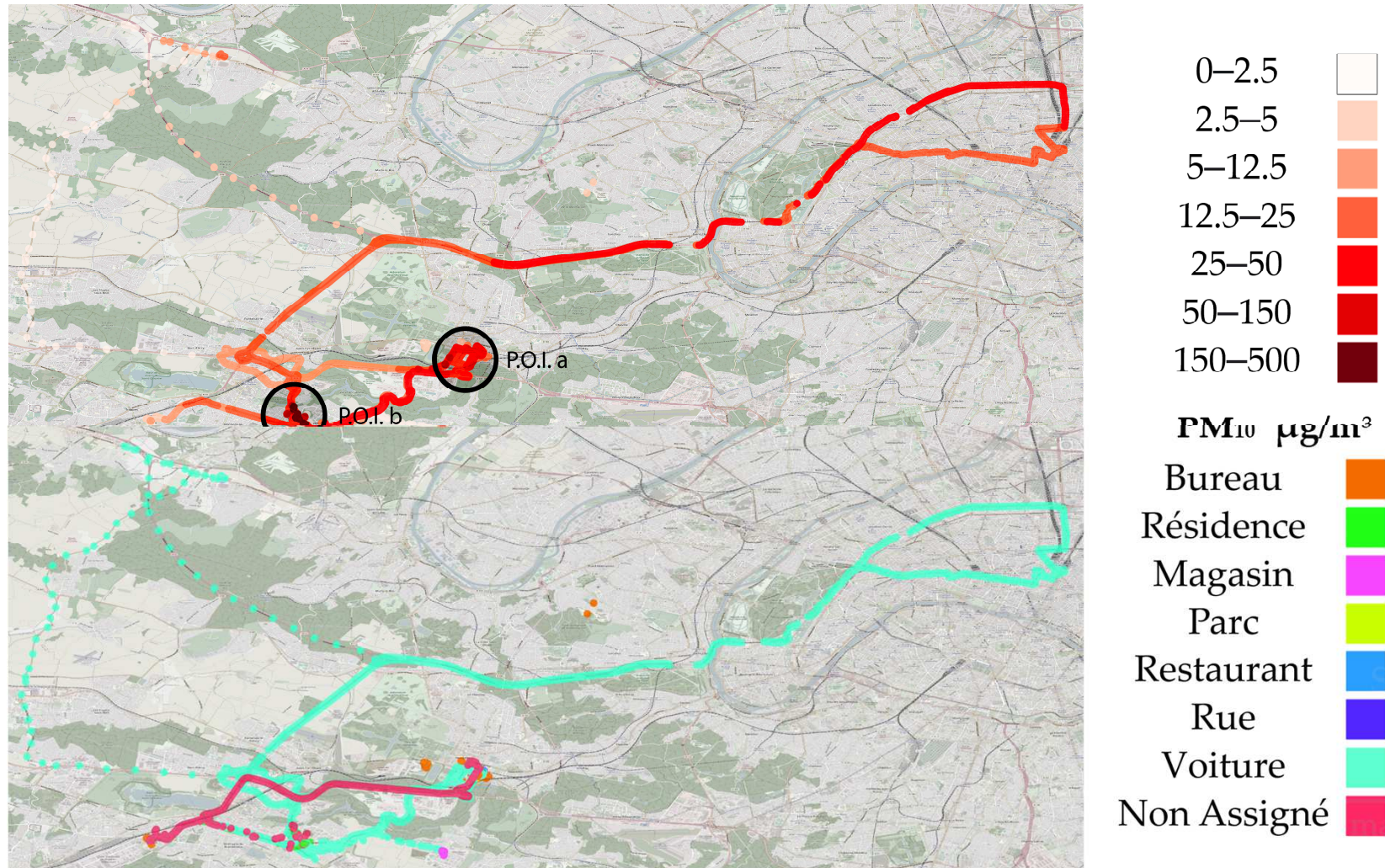
Academically Produced Air Pollution Sensors for Personal Exposure Assessment: The Canarin Project

Boris Dessimond ^{1,2,*}, Isabella Annesi-Maesano ², Jean-Louis Pepin ³, Salim Srairi ⁴ and Giovanni Pau ¹

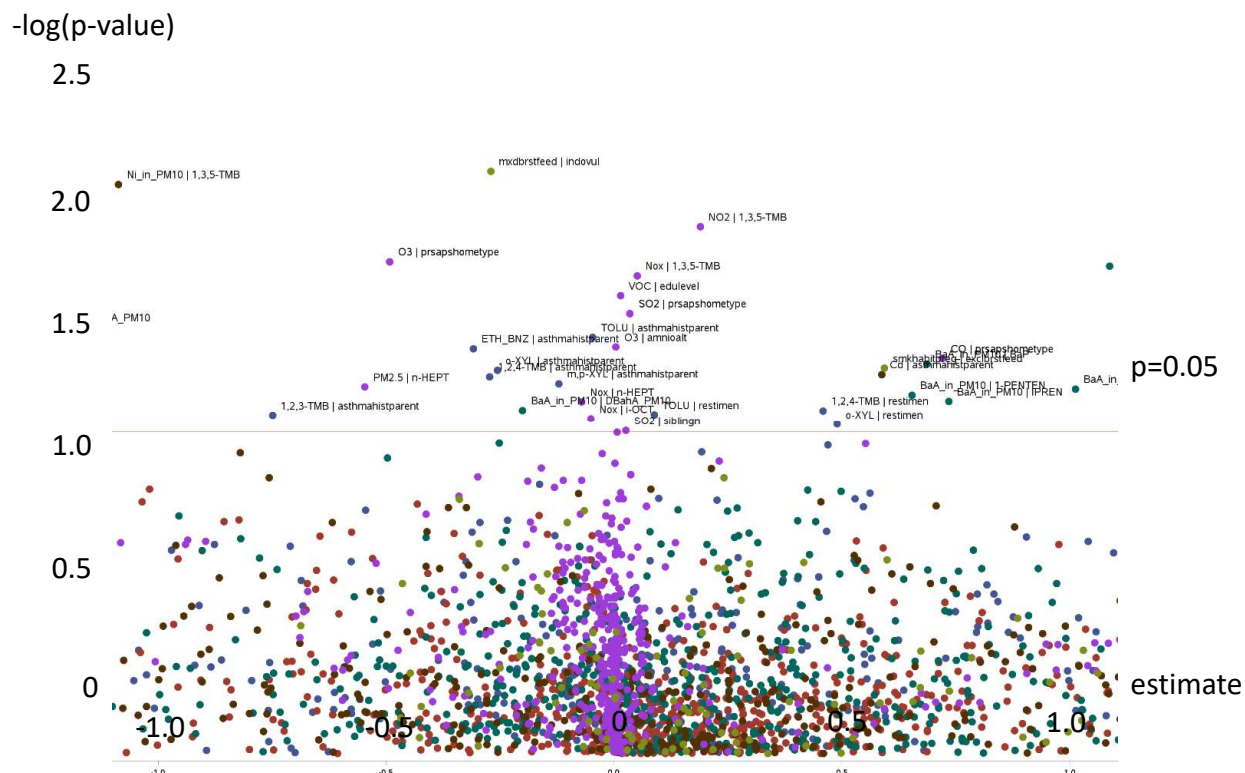
¹ Computer Science Laboratory, University of Pierre et Marie Curie, LIP6, NPA Team, 4 Place Jussieu,



GEOLOCALISATION OF INDIVIDUAL EXPOSURE



Environment-Wide Association Studies (EnvWAS) in asthma in HEALS twins (lifetime exposure) (HEALS)

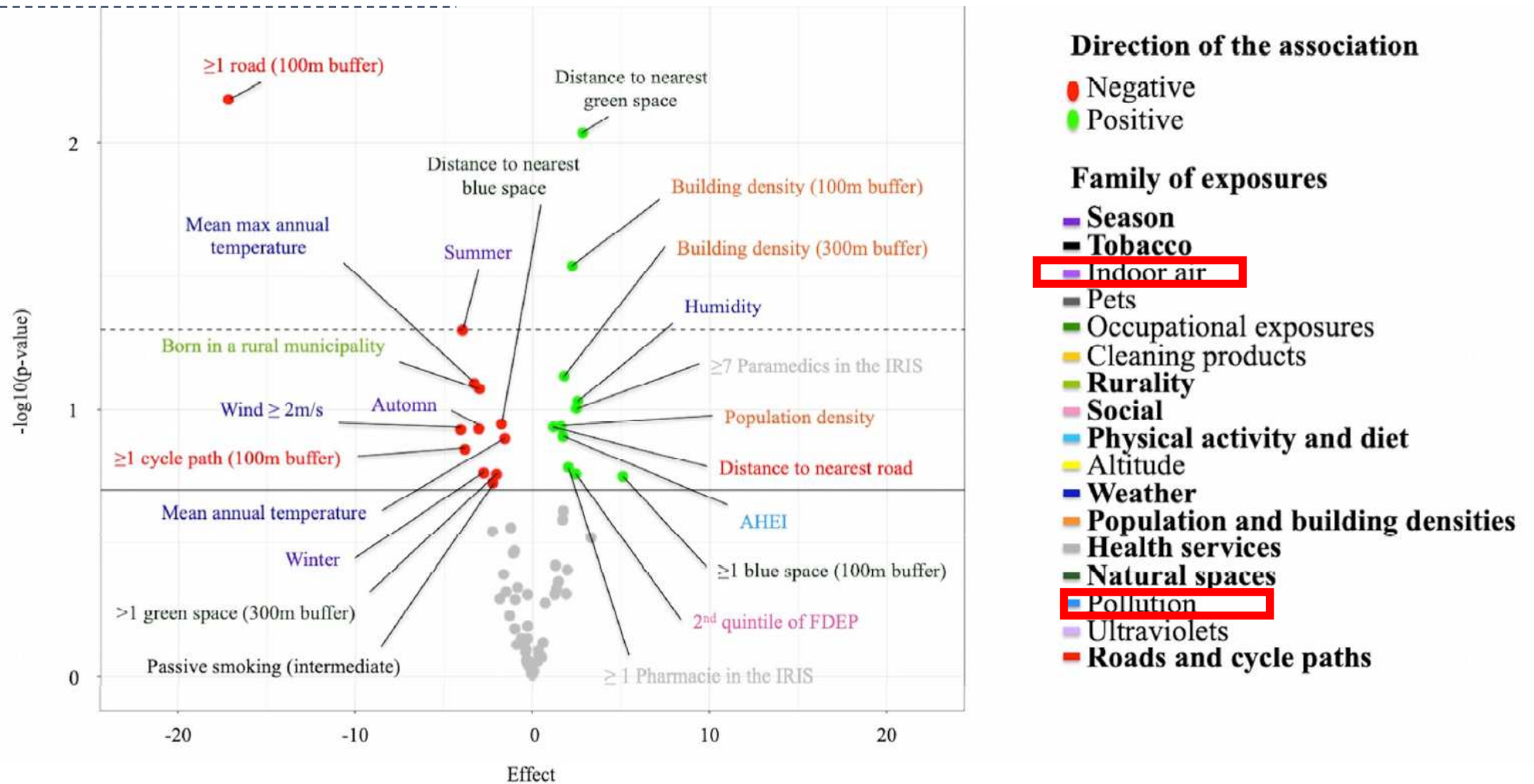


•522 / 36 / 37 significant interactions (raw p-value / Bonferroni / FDR)

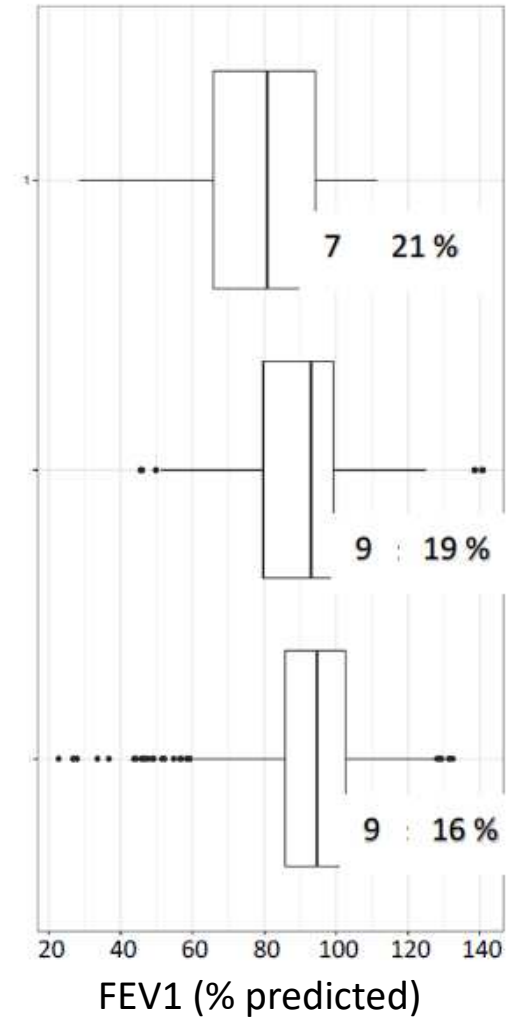
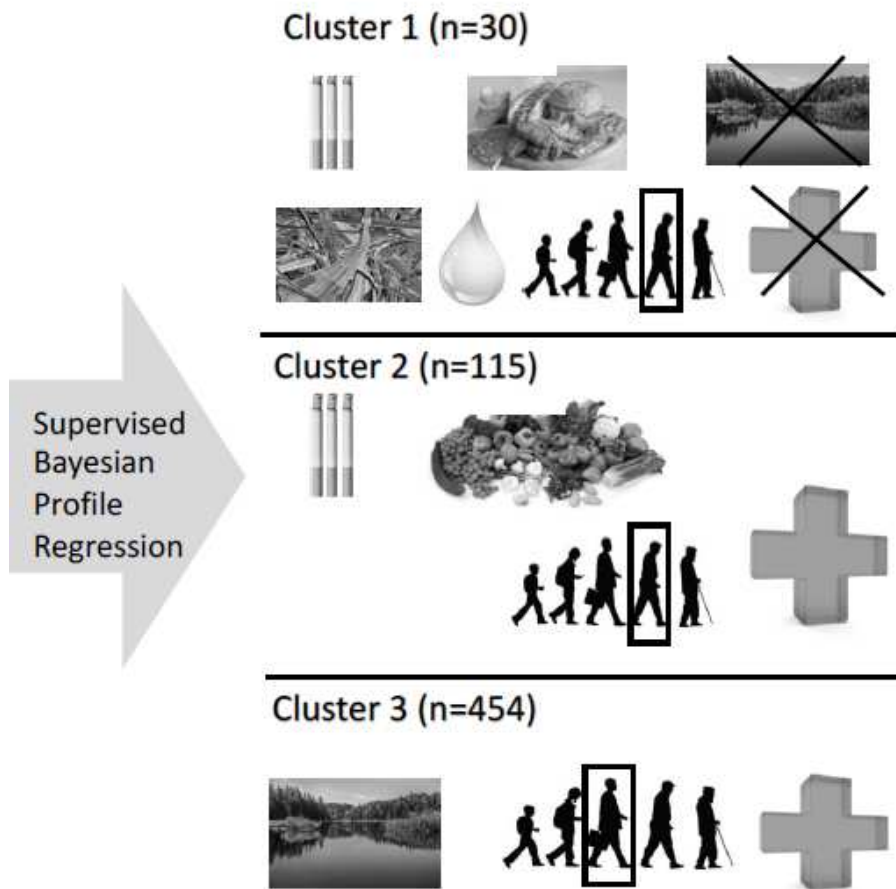
•Significant interactions with correction for multiple hypotheses testing included:
benzene derivatives, acyclic carbon derivatives, metals and life habits

Submitted

Interactions among factors and asthma. EGEA Study



Clustering in EGEA Study







Environment International

Volume 173, March 2023, 107849




Full length article

Effect of residential relocation on environmental exposures in European cohorts: An exposome-wide approach

Apolline Saucy^{a b c}, Ulrike Gehring^d, Sergio Olmos^{a b c}, Cyrille Delpierre^e,
Jeroen de Bont^f, Olena Gruzieva^f, Kees de Hoogh^{g h}, Anke Huss^d,
Petter Ljungman^{f i}, Erik Melén^j, Åsa Persson^f, Inka Pieterse^d, Marjan Tewis^d,
Zhebin Yu^f, Roel Vermeulen^d, Jelle Vlaanderen^d, Cathryn Tonne^{a b c}  

Full length article

Effect of residential relocation on environmental exposures in European cohorts: An exposome-wide approach

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Zhebin Yu^l, Roel Vermeulen^d, Jelle Vlielanden^d, Cathryn Tonne^{a, b, c} 

household characteristics, health behaviors and health. We identified exposure clusters reflecting three domains of the urban exposome (air pollution, grey surface, and socioeconomic deprivation) and conducted multinomial logistic regression to identify predictors of exposome trajectories among movers.

On average, 7 % of the participants relocated each year. Before relocating, movers were consistently exposed to higher levels of air pollution than non-movers. Predictors of moving differed between the adult and birth cohorts, highlighting the importance of life stages. In the adult cohorts, moving was associated with younger age, smoking, and lower education and was independent of cardio-respiratory health indicators (hypertension, BMI, asthma, COPD). Contrary to adult cohorts, higher parental education and household socioeconomic position were associated with a higher probability of relocation in birth cohorts, alongside being the first child and living in a multi-unit dwelling. Among movers in all cohorts, those with a higher socioeconomic position at baseline were more likely to move towards healthier levels of the urban exposome.

We provide new insights into predictors of relocation and subsequent changes in multiple aspects of the urban exposome in four cohorts covering different life stages in Sweden and the Netherlands. These results inform strategies to limit bias due to residential self-selection in epidemiological studies using relocation as a natural experiment.

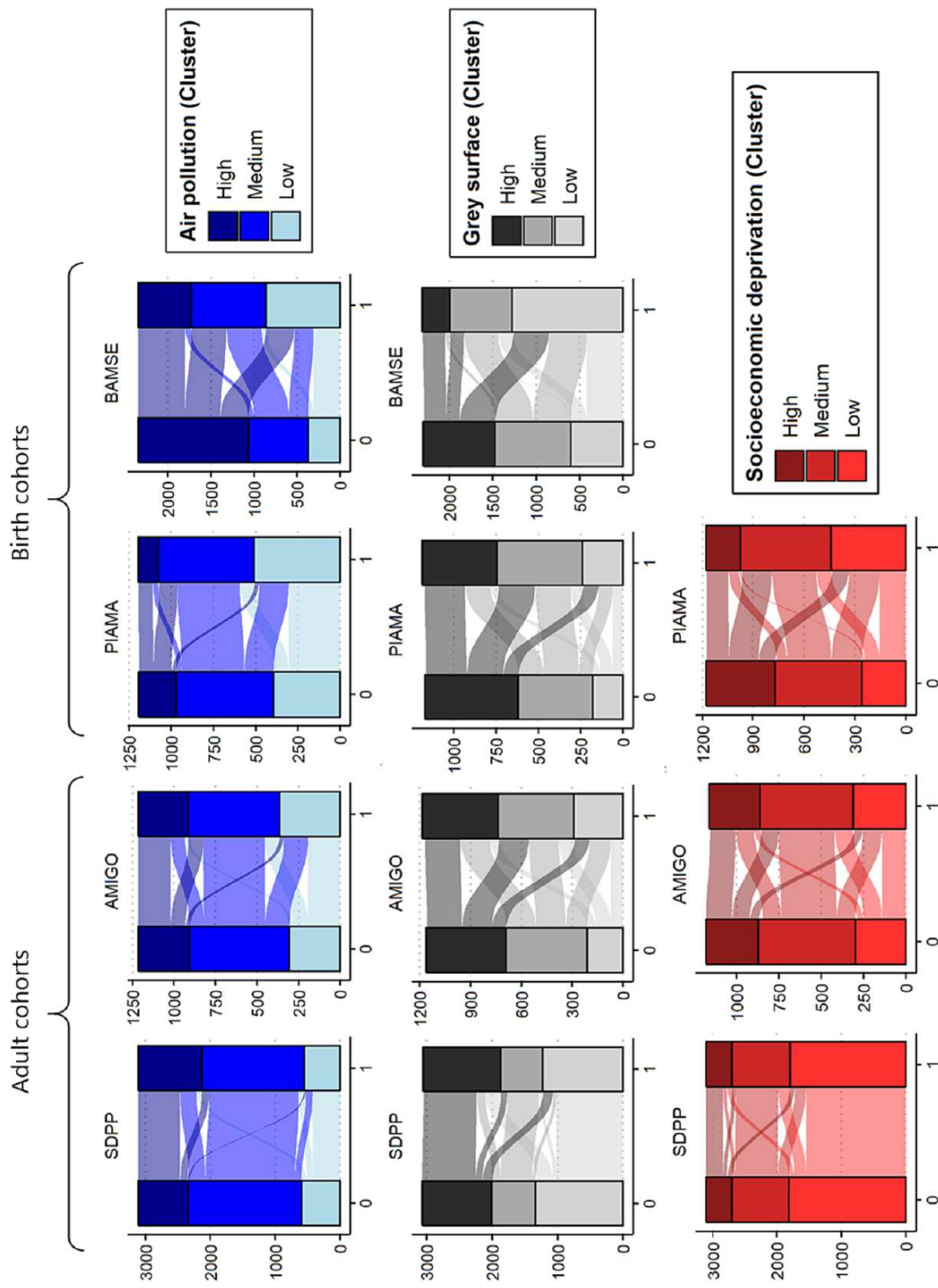
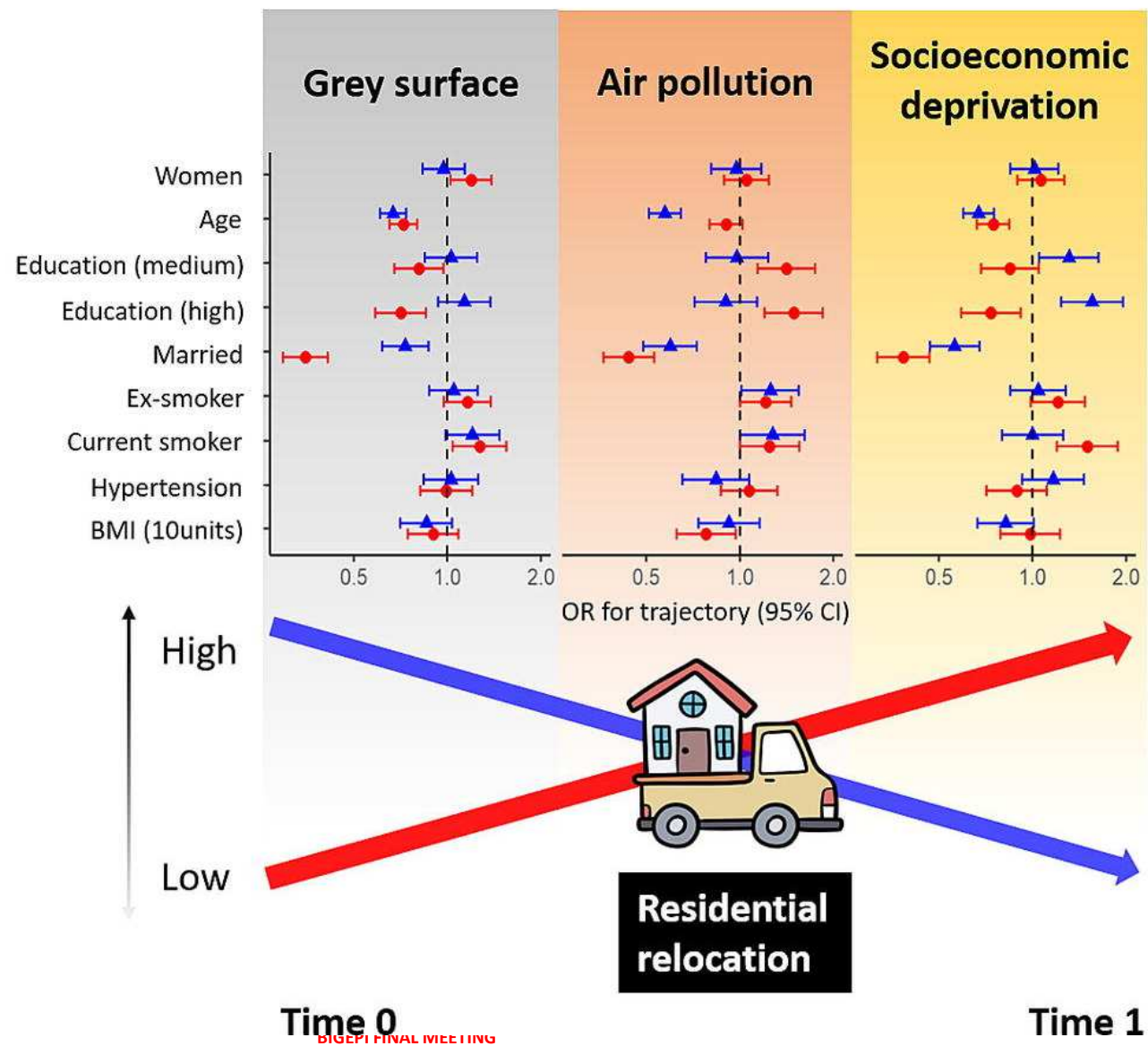


Fig. 4. Changes in cluster levels for three domains of the urban exposome among movers between T0 and T1: air pollution (top panel), grey surface (middle panel) and socioeconomic deprivation (bottom panel). Lower cluster levels represent lower levels of air pollution, grey surface and socioeconomic deprivation. Note: clusters were built separately for each cohort and cluster distributions at given times cannot be compared across cohorts.

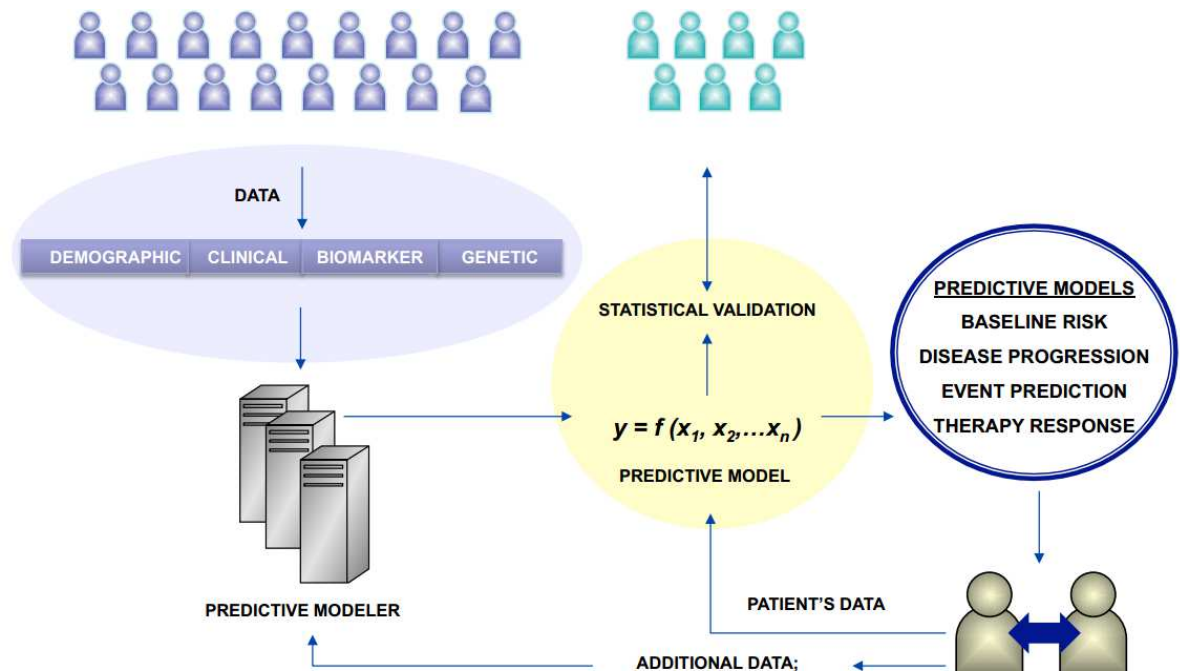


DIGEP1 FINAL MEETING

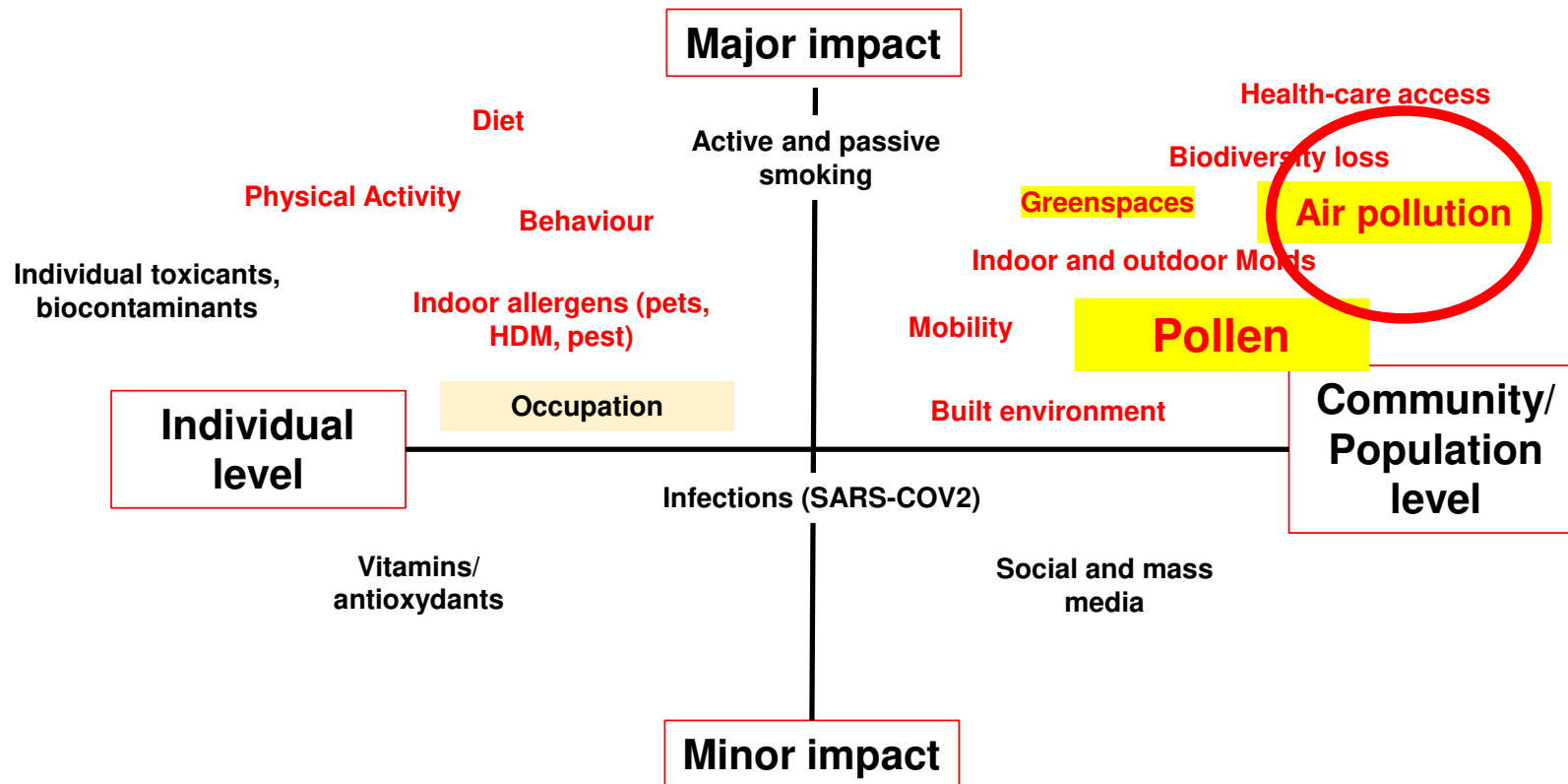
Predictive model development for risk assessment

○ The promising potential of exposome is that it will provide the basis for evidence based health interventions:

| Both collective public health strategies and personalized intervention strategies



Modifiable exposome



Common risk factors plotted along axes to include their relevance in asthma and allergy (minor to major) and the ability to control these factors at the individual, community and population levels through (in red) mitigation or adaptation

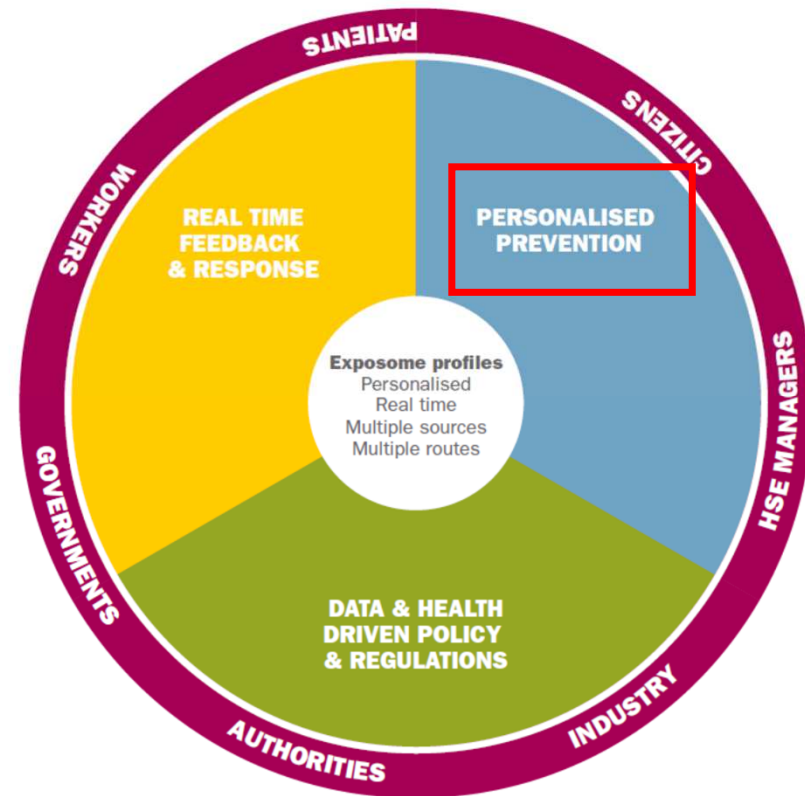
Impact depends on available evidence

BIGEPI FINAL MEETING

Prevention



- Developed knowledge and technologies provide a range of opportunities for prevention:
 - Several targets (patients, workers...)
 - (Self) management and E-health solutions



WHAT CAN BE DONE?

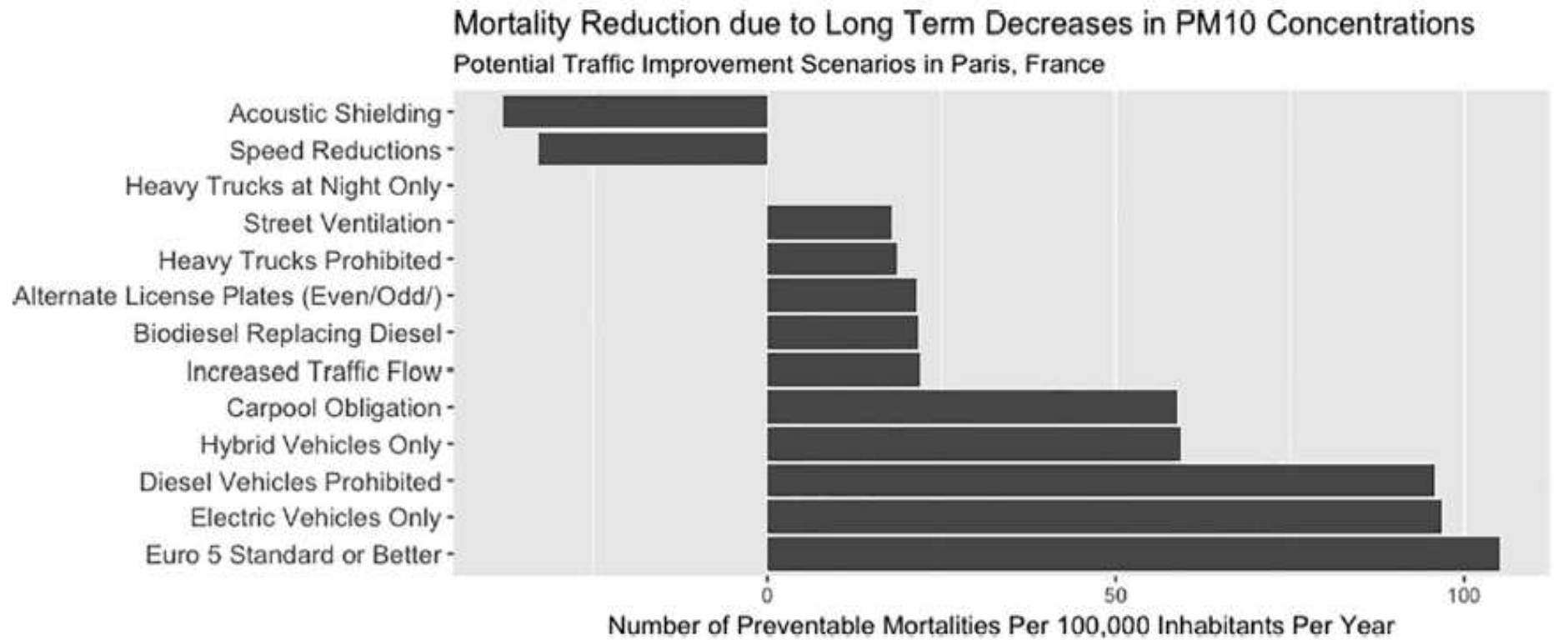
Intervention studies

Scenari di prevenzione



Fig. 2. A map of the 14th district of Paris (shown in inset) with the traffic route of interest highlighted in blue. PM_{10} measurements were taken at the location shown in red, near a large traffic circle. It is worth noting that there is a large highway surrounding Paris which is not shown on the map but approximately located along Blvd Brune along the south edge of the map, less than 1 km from the monitoring site. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

GRAPHICAL ABSTRACT



Conclusioni

Nel caso dell'inquinamento atmosferico, l'approccio esposomico contribuisce a:

- Misurare l'esposizione in modo da evitare missclassification e considerando anche inquinanti emergenti
- Prendere in conto le interazioni degli inquinanti con altri fattori di rischio nell'ambito della vita reale
- Proporre et valutare le misure di prevenzione

Ma ancora pochi risultati



<https://idesp.umontpellier.fr/>



Institut national de la santé et de la recherche médicale

