

BIOGRAPHICAL SKETCH

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NAME: Bind, Marie-Abele

eRA COMMONS USER NAME (credential, e.g., agency login): MABIND

POSITION TITLE: Instructor of Investigation (Massachusetts General Hospital)

EDUCATION/TRAINING (*Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.*)

INSTITUTION AND LOCATION	DEGREE (if applicable)	Completion Date MM/YYYY	FIELD OF STUDY
Lycee Saint Louis, Paris	CPGE*	06/2004	Mathematics, Physics, and Engineering Sciences
Engineering School EPF**, Paris	MS	06/2007	General engineering, specialization in Energy and Environment
CII*** for the Environment and Public Health in association with HSPH****, Nicosia	MS	08/2008	Environment and Health
Harvard University Center for the Environment, Cambridge, MA	Graduate Consortium	06/2012	Energy and Environment
Harvard School of Public Health, Boston, MA	ScD	03/2014	Dual Sc.D. degree in Environmental Epidemiology and Biostatistics
Harvard School of Public Health, Boston, MA	Postdoctoral Fellow	08/2014	Environmental epidemiology and Biostatistics
Department of Statistics, Harvard University, Cambridge, MA	Postdoctoral Fellow	08/2016	Environmental statistics

*CPGE: Classes Préparatoires aux Grandes Ecoles, **EPF: Ecole Polytechnique Feminine, ***CII: Cyprus International Institute, ****HSPH: Harvard School of Public Health

A. Personal Statement

The base of expertise needed to carry out statistical consulting began to develop while I was under the joint doctoral guidance of Profs. Schwartz and Coull at the Harvard School of Public Health (HSPH). During the same period, I improved my training with leading experts in disciplinary areas that are directly related to the subject of this application, such as causal mediation analysis (e.g., Prof. VanderWeele), with whom I chose to work. During the Spring 2012 semester, my graduate studies were disrupted due to my father's illness, and I was situated in France. However, upon returning to the US, I immediately resumed my coursework, research projects, and collaborations. Since the beginning of my thesis, I attended and presented my work at national and international research meetings, e.g., organized by the International Society for Environmental Epidemiologists. I have also been invited to give talks and short courses on causal inference in prestigious international research institutes and universities. As a postdoctoral fellow at HSPH, I conducted research on susceptibility to air pollution and temperature effects in an elderly population. Because of my expertise in epigenetics and my statistical skills on analyzing high-dimensional data, I was contacted by Dr. Devlin (EPA) to conduct the causal analysis of epigenomics data collected during a cross-over experiment, randomizing healthy participants to clean air and ozone. As a Ziff postdoctoral fellow at the Harvard University Center for the Environment, I learned how to apply the Rubin Causal Model (RCM) to estimate the causal effect of a non-randomized exposure under the intellectual guidance of Prof. Rubin. In Fall 2014, I also opted to audit

statistical courses in design of experiments (jointly taught by Dr. Dasgupta and Prof. Rubin), classical multivariate analysis (Prof. Kou), Bayesian analysis (Prof. Liu), which completed much of my biostatistics training. In 2016, I have been awarded an NIH Early Independence Award and then became a John Harvard Distinguished Science Fellow.

In 2017, I co-developed and applied a “causal inference pipeline” that embeds observational studies into hypothetical randomized experiments to estimate causal effects of single or multiple non-randomized exposures. In 2020, I have promoted the use of randomization-based inference. In 2021, I have accepted an academic position of Instructor of Investigation at Massachusetts General Hospital. I am being recommended for a faculty appointment as Assistant Professor at the Harvard Medical School.

B. Positions and Honors

- 2005 **Engineering intern, Renault Testing Center, Gearshift performance, Paris, France**
Project: Optimizing synchronizer (gearbox part) and separation torque, certifying the measure of Renault’s and suppliers’ benches with a standard tool, and demonstrating a relationship between synchronizer ring’s stiffness and stick
- 2006 **Summer intern, GSF Center of Research for Environment and Health, Department of Epidemiology, Munich, Research mentor: Prof. Peters**
Project: Assisting on the final European Union report of the AIRGENE project on the risks of heart attacks due to air pollution
- 2007 **Engineering intern, Harvard School of Public Health, Department of Environmental Health, Boston, MA, Research advisor: Prof. Schwartz**
Project: Improvement of space and time variations in environmental health studies
- 2008–2014 **Doctoral student, Harvard School of Public Health, Departments of Environmental Health and Biostatistics, Boston, MA, Research advisors: Profs. Schwartz and Coull**
Dissertation: Statistical methods to investigate the role of genetic and epigenetic mechanisms in air pollution and temperature health effects
- 2014/02–2014/08 **Postdoctoral Fellow, Departments of Environmental Health and Biostatistics, Harvard School of Public Health, Boston, MA, Research mentors: Profs. Schwartz and Coull**
Project: Susceptibility to air pollution and temperature effects
- 2014/09–2016/07 **Postdoctoral Ziff Fellow, Department of Statistics and Center for the Environment, Harvard University, Cambridge, MA, Research mentor: Prof. Rubin**
Project: Causal effect of temperature increases due to climate change on cardiovascular morbidity and mortality, especially in susceptible populations
- 2016–2021 **John Harvard Distinguished Science Fellow and Associate, Department of Statistics, Harvard University**
Project: Transporting established insights from classical experimental design to address causal questions in environmental epidemiology including the understanding of biological mediating mechanisms
- 2021– **Instructor of Investigation, Massachusetts General Hospital/Harvard Medical School**
Project: Developing and applying causal inference methods to biomedical studies

Honors

- 2007 Best student award, Engineering School EPF
- 2007–2014 Cyprus Fund Scholarship (Cyprus government and Harvard University)
- 2008–2011 Arthur Sachs Scholarship (French and US foundation)
- 2010 Jean Gaillard Memorial Fellowship Fund (French foundation)
- 2011–2012 Graduate consortium Fellowship (Harvard University Center for the Environment)
- 2016 Young researcher award (Air quality conference)
- 2017 NIH Early Independence Award (DP5)
- 2020 Extraordinary Teaching in Extraordinary Times Award (Harvard University)

Teaching Experience

Lecture for graduate-level course in Statistics

2020 Design of experiments (Statistics, FAS*)

Teaching assistant for graduate-level courses in Environmental Health, Epidemiology, Statistics

2017–2018 Causal inference guest lectures (Munich, UCLA, FAS*)
2016 Statistical methods for evaluating causal effects (Statistics, FAS*)
2015 Matched sampling and study design (Statistics, FAS*)
2014 Methods for mediation and interaction (Epidemiology, HSPH**)
2013–2014 Analysis of cohort and case-control studies (Epidemiology, HSPH**)
2009–2012 Introduction to data management and programming in SAS (Biostatistics, HSPH**)
2011 Advanced regressions for environmental epidemiologists (Biostatistics, HSPH**)
2010 Exposure assessment (Environmental Health, HSPH**)
2010 Human Health and Global Environmental Change (Global Health, HSPH**)
2009 Environmental cardiology (Environmental Health, HSPH**)

*FAS: Faculty of Arts and Sciences (Harvard University), **HSPH: Harvard School of Public Health

Professional Membership

2011– Member, International Society for Environmental Epidemiology (ISEE)
2016, 2020 Member, American Statistical Association (ASA)

Journal Referee and Peer Review Invitations

2013– Scientific Reports, Social Science Research, Annals of Applied Statistics, R Journal, BMC, Environmental Research, JESEE, STOTEN IJERPH, AJPH, BMJ, Environment International, Environmental Research Epidemiology, Journal of the Royal Statistical Society, Environmental Research, Social Science Research Epidemiology

C. Contributions to Science

1. Development of new causal inference methods

Most environmental epidemiological studies have reported associations between environmental exposures and health outcomes. Associations are not optimal for making policy recommendations. The first two papers develop a statistical framework that embeds observational studies into hypothetical randomized experiments to draw causal inferences in non-randomized studies (i.e., “causal inference pipeline”). The third paper develops Fisherian inference methods for observational studies designed by propensity score matching. The fourth paper discusses the importance of randomization-based inference in small randomized studies.

- Bind MA** and Rubin D. Bridging observational studies and randomized experiments by embedding the former in the latter. *Statistical Methods in Medical Research*, 2019 Jul;28(7):1958-1978.
- Pashley N and **Bind MA**. Causal inference for multiple non-randomized treatments using fractional factorial designs. *arXiv preprint arXiv:1905.07596*, 2019 - arxiv.org
- Branson Z and **Bind MA**. Randomization-based inference for Bernoulli trial experiments and implications for observational studies. *Statistical Methods in Medical Research*, 2019 May;28(5):1378-1398.
- Bind MA** and Rubin D. When possible, report Fisher-exact p-values and display the underlying Fisherian null randomization distributions. *Proceedings of the (US) National Academy of Sciences*, Jul 2020. 117(32):201915454. DOI: 10.1073/pnas.1915454117

2. Causal inference in environmental epidemiology

The first paper presents a historical review of statistical models, associational and causal, used in environmental epidemiology. The second study aims to address causality between meteorological variables and crimes and illustrates the causal inference pipeline. The third and fourth estimate the causal effects of air pollution on multiple sclerosis relapses and on the human gut microbiome.

- Bind MA**. Causal Modeling in Environmental Health, *Annual Review in Public Health*, 2019 Apr 1;40:23- 43.

- b. Sommer A, Lee M, and **Bind MA**. Comparing apples to apples: an environmental criminology analysis of the effects of heat and rain on violent crimes in Boston. *Palgrave Communications*. 2018; 4:138.
- c. Sommer A, Leray E, Lee Y, and **Bind MA**. Assessing environmental epidemiology questions in practice with a causal inference pipeline: An investigation of the air pollution-multiple sclerosis relapses relationship. *Statistics in Medicine*. 2021 Mar 15;40(6):1321-1335. doi: 10.1002/sim.8843. Epub 2020 Dec 16.
- d. Sommer A, Peters A, Cyrus J, Grallert H, Haller D, Christian Müller C, and **Bind MA**. A randomization-based causal inference framework for uncovering environmental exposure effects on human gut microbiota. *bioRxiv* 2021.02.24.432662; doi: <https://doi.org/10.1101/2021.02.24.432662>

3. Mediation methods

My co-authors and I developed methods for causal mediation analysis, in particular mixed-effects and quantile causal mediation models, and derived mediation formula for longitudinal data.

- a. **Bind MA**, Vanderweele T, Coull B, and Schwartz J. Causal mediation analysis for longitudinal data with endogenous exposure, *Biostatistics*, 2016 Jan;17(1):122-34.
- b. **Bind MA**, T. VanderWeele, J. Schwartz, and B. Coull, Quantile causal mediation analysis allowing longitudinal data. *Statistics in Medicine*, 2017 Nov 20;36(26):4182-4195.
- c. **Bind MA**, Lepeule J, Zanobetti A, Gasparrini A, et al. Air pollution and gene-specific methylation in the Normative Aging Study: association, effect modification, and mediation analysis. *Epigenetics*, 2014 Mar;9(3):448-58.
- d. Devick K, Valeri L, Chen J, Jara A, **Bind MA**, and Coull B. The role of Body Mass Index at Diagnosis on Black-White Disparities in Colorectal Cancer Survival: A Density Regression Mediation Approach. *Biostatistics*. 2020 Sep 24; kxaa034.

4. Quantifying the neurological effects of pollutants

My recent research has focused on quantifying the neurodevelopmental effects of pollutant exposures. The first paper estimates associations between air pollution exposure and multiple sclerosis relapses. The second paper reports associations between prenatal mercury exposure and lower cognitive function. The third paper provides an overview of recent toxicological research in larval zebrafish and highlights the usefulness of the model system to toxicology. The fourth paper estimates the neurodevelopmental effects of mycotoxins.

- a. Jeanjean M, **Bind MA**, Roux J, Ongagna JC, de Sèze J, Bard D, Leray E. Ozone, NO₂ and PM₁₀ are associated with the occurrence of multiple sclerosis relapses. Evidence from seasonal multi-pollutant analyses. *Environmental Research*. 2018 May;163:43-52. doi: 10.1016/j.envres.2018.01.040. Epub 2018 Feb 6. PMID: 29426027; PMCID: PMC5886008.
- b. Oulhote Y, Coull B, **Bind MA**, Debes F, Nielsen F, Tamayo I, Weihe P, Grandjean P Joint and independent neurotoxic effects of early life exposures to a chemical mixture: A multi-pollutant approach combining ensemble learning and g-computation. *Environmental Epidemiology*, 2019 Oct;3(5):e063. PMCID: PMC7015154
- c. Juan-Garcia A, **Bind MA**, Engert F. Larval zebrafish as an in vitro model for evaluating toxicological effects of mycotoxins. *Ecotoxicology and Environmental Safety*, 2020 Oct 1;202:110909. PMCID: PMC7431674
- d. Juan-Garcia A, Juan C, **Bind MA**, Engert F. Study of locomotion response and development in zebrafish (*Danio rerio*) embryos and larvae exposed to enniatin A, enniatin B, and beauvericin. *Science of the Total Environment*, in press

5. Genetic and epigenetic susceptibility to air pollution health effects

With my collaborators, I have observed genetic and epigenetic susceptibility to air pollution effects with test of effect modification and with quantile regression for longitudinal data that quantifies distributional distortions. Compared to mean regression analyses, quantile regression captured associations that occur primarily in the tails of the outcome distribution. The first paper focused on associations of air pollution with pulmonary and cardiovascular outcomes and investigating susceptibility by genetic variants related to oxidative stress, metal processing, and endothelial function. The 2012 manuscript was the first study to document epigene-air pollution interactions. I have co-authored the third paper that has followed this idea with other health outcomes. The fourth paper used quantile regression models for longitudinal data and

suggested that the impact of air pollution may be stronger in individuals whose DNA methylation levels of inflammation markers were low.

- a. **Bind MA**, Coull B, Suh H, Wright R, Baccarelli A, et al., A novel genetic score approach using instruments to investigate interactions between pathways and environment: application to air pollution. *PLoS One*, 2014 Apr 22;9(4):e96000. PMID: PMC3995963
- b. **Bind MA**, Baccarelli A, Zanobetti A, Tarantini L, Suh H, et al., Air pollution and markers of coagulation, inflammation, and endothelial function: associations and epigene-environment interactions in an elderly cohort. *Epidemiology*, 2012 Mar;23(2):332-40. PMID: PMC3285258
- c. Lepeule J, **Bind MA**, Baccarelli A, Koutrakis P, Tarantini L, et al. Epigenetic influences on associations between air pollutants and lung function in elderly men: the normative aging study. *Environmental Health Perspectives*, 2014 Jun;122(6):566-72. PMID: PMC4050500
- d. **Bind MA**, Coull B, Peters A, Baccarelli A, Tarantini L, Cantone L, Vokonas P, Koutrakis P, Schwartz J. Beyond the Mean: Quantile Regression to Explore the Association of Air Pollution with Gene-Specific Methylation in the Normative Aging Study. *Environmental Health Perspectives*, 2015 Aug; 123(8): 759–765. PMID: PMC4529003

Complete List of Published Work in MyBibliography:

<https://www.ncbi.nlm.nih.gov/myncbi/marie-abele.bind.1/bibliography/public/>

D. Additional Information: Research Support and/or Scholastic Performance

Ongoing Research Support

DP5OD021412 2016–2022
NIH Early Independence Award

Transporting established insights from classical experimental design to address causal questions in environmental epidemiology including the understanding of biological mediating mechanisms
Role: Principal investigator

P42ES027706 2020–2022
NIH Multiproject Center Grant Award

STEEP Project 2: Sources, Transport, Exposure, and Effects of Perfluoroalkyl Substances (STEEP) Center
Role: Collaborator

R01AG066828 2020–2025
NIH Research Project Grant Program

Metabolic regulation of human DNA methylation clocks in aging
Role: Co-Investigator