Call for Applications for a Doctoral Position

2026-2029

TERRA-HEALTH: Territorial Exposome and Behavioral Pathways in Cardio-Kidney-Metabolic Health Inequalities

1. Background and Project Overview

Environmental transformations and the rising prevalence of cardio-kidney-metabolic diseases raise a major scientific and policy challenge: understanding how environmental exposures, individual behaviors, and socio-territorial inequalities jointly shape health trajectories. While environmental epidemiology has extensively documented the adverse effects of air pollution, noise, and degraded environments on cardiovascular risk (Brook et al., 2010; Münzel et al., 2018), a growing body of literature highlights the protective role of natural environments such as greenness and urban canopy, through physiological and psychosocial pathways including stress reduction and increased physical activity (Kondo et al., 2018; Astell-Burt and Feng, 2020; Qiu et al., 2022). While research often targets single systems, such as cardiovascular health, the underlying pathophysiology is progressive and interconnected, leading to increased absolute cardiovascular risk. Adopting a multisystem approach is crucial to better understand the continuum linking cardiovascular, kidney, and metabolic diseases (Ndumele et al., 2023). In parallel, research in nutrition and social sciences shows that health-related behaviors are strongly shaped by spatial and socio-economic contexts, particularly through food environments and access to resources (Hu, 2002; Turner et al., 2018).

However, these strands of literature largely remain fragmented. Most studies focus on single exposures, rarely account for behavioral mediations, and insufficiently integrate spatial inequalities and biological mechanisms. As a result, the identification of causal pathways linking environmental exposures to health outcomes, and the understanding of socio-territorial health inequalities, remain limited. The exposome framework (Wild, 2012) offers a promising integrative perspective, but its empirical implementation combining longitudinal, spatial, behavioral, and biological data is still scarce.

Among emerging environmental exposures, persistent pollutants such as per- and polyfluoroalkyl substances (PFAS) provide a particularly relevant case to illustrate both the complexity of environmental risks and the current limits of existing analytical frameworks.

PFAS exposure is associated with alterations in both traditional lipid profiles and sphingolipid metabolism. Meta-analyses demonstrate that PFOA and PFOS exposure significantly increases total cholesterol and LDL cholesterol levels in adults, while emerging evidence reveals that

PFAS also disrupts sphingolipid pathways, particularly affecting ceramide and sphingomyelin levels. However, only few PFAS have been evaluated.

In this context, the TERRA-HEALTH project proposes an integrated exposome approach to investigate how environmental exposures interact with behaviors and biological pathways to shape cardio-renal health trajectories and inequalities. A particular focus will be placed on emerging lipid biomarkers, including sphingolipids, which are increasingly implicated in cardiovascular and metabolic risk and may represent key mediators of environmental effects, especially those related to PFAS exposure.

Objectives of the Doctoral Project

1. Characterize the territorial exposome by integrating multiple environmental exposures (air pollution, noise, greenness, land use, climate, PFAS).

2. Study the association of environmental exposures with cardio-kidney-metabolic outcomes.

3. Identify behavioral and biological mediators, with a focus on diet, physical activity, stress, proteomic and lipidomic profiles (including sphingolipids).

2. Supervision and Research Environment

PhD Supervisors

Nicolas Girerd is a cardiologist and coordinator of the Multidisciplinary Clinical Investigation Center (CIC-P). Internationally recognized, he is ranked among the world experts in heart failure on Expertscape. His research focuses on improving the understanding of the mechanisms underlying the emergence and progression of cardiovascular diseases, particularly heart failure.

Youba Ndiaye is an Associate Professor in Economics at the University of Lorraine and a member of the Bureau of Theoretical and Applied Economics (BETA) laboratory in Nancy. His research lies at the intersection of environmental economics, with a particular interest in spatial interactions and the evaluation of public policies using applied and spatial econometric tools.

Host Research Units

The CIC-P affiliated with Nancy University Hospital, is dedicated to clinical and epidemiological research. It provides advanced methodological and statistical expertise as well as privileged access to large-scale clinical and longitudinal cohort data, particularly the STANISLAS cohort. The CIC-P is a key actor in the production and analysis of health data related to cardio-renal diseases and their risk factors. It includes a research axis dedicated to nutrition and cardio-renal health.

The BETA is a joint research unit specializing in applied economics, recognized for its work in health economics, environmental economics, and econometrics. Economic challenges related to health and aging are central topics within the unit, particularly in the context of healthcare resource allocation and demographic transition.

The PhD project will be jointly conducted between BETA and CIC-P.

Partners

The project will benefit from the expertise of the CaRMeN Laboratory in the field of lipid research.

3. Proposed PhD Topic

This PhD project will be structured around three main research axes based on the STANISLAS cohort, a family-based cohort from Lorraine that initially included more than 4,000 healthy volunteers between 1993 and 1995 and followed them over 20 years (visits every 5 to 10 years). Socio-demographic, dietary, clinical, and biological data were collected, along with extensive cardiovascular phenotyping enabling the assessment of subclinical cardiovascular damage such as arterial stiffness and atherosclerosis.

Axis 1. Construction of environmental exposure models (exposome mapping)

Environmental variables will be compiled from public databases, including air pollutants, greenhouse gases, vegetation, urban green-space access, low-emission zones, noise, land use, climate indicators, food environments, urban form, accessibility and land artificialization. These spatial layers will be linked to geocoded residential trajectories using appropriate methods, including modeled data, land-use regression, satellite indicators, and distance- or neighborhood-based measures. Residential mobility, environmental change and exposure windows will be incorporated to build life-course exposure histories. Composite exposome indicators will be constructed, and clustering methods will be applied to identify territorial profiles combining favorable and unfavorable environmental conditions.

Axis 2. Environmental effects and cardio-renal health

Axis 2 will estimate associations between environmental exposures and cardio-kidney-metabolic outcomes. Longitudinal models will account for individual, socioeconomic, spatial, and temporal factors. Where the data and identification strategy allow, quasi-experimental approaches or reweighting methods will strengthen causal interpretation. Analyses will examine exposure mixtures, non-linearities, thresholds, and heterogeneous effects.

Axis 3. Exploration of underlying behavioral and biological mechanisms

Axis 3 will investigate behavioral and biological mechanisms linking environmental exposures to health. The objective is to quantify the contribution of modifiable behavioral mechanisms and emerging biological pathways, while examining interactions between mediators. Particular attention will be paid to sphingolipids as mediators of environmental exposures, especially PFAS, on cardio-metabolic and cardio-renal risk. These analyses leverage high-dimensional biological data and follow a hypothesis-driven strategy based on predefined molecular pathways.

To better characterize biological mechanisms, we will use advanced statistical tools, including machine learning and network analysis, to identify complex and non-linear relationships between exposures, proteins, and health outcomes. The Fight-HF Knowledge Graph (Girerd et al., 2020) will provide the structural basis, integrating UniProt, STRING, and REACTOME data.

Pathway identification will be adapted to the number and characteristics of identified proteins. For a limited set, predefined query patterns will explore protein-pathway relationships (Stienen et al., 2020). For larger sets, over-representation analyses will identify enriched pathways. Network analysis will then highlight key interactions. These analyses will be exploratory and hypothesis-generating when appropriate, building on CIC-P approaches (Kobayashi et al., 2022; Rastogi et al., 2022).

All analyses will control for key confounders (socio-economic factors, genetic background, spatial context) and rely on longitudinal frameworks to strengthen causal interpretation.

Bibliography

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12. Kobayashi, M. *et al.* Machine Learning-Derived Echocardiographic Phenotypes Predict Heart Failure Incidence in Asymptomatic Individuals. *JACC: Cardiovascular Imaging* **15**, 193–208 (2022).

13. Rastogi, T. *et al.* Impact of smoking on cardiovascular risk and premature ageing: Findings from the STANISLAS cohort. *Atherosclerosis* **346**, 1–9 (2022).

1. Candidate Profile

Required Degree

- Master's degree in Public Health, Epidemiology, Biostatistics applied to Life Sciences, or economics or a related quantitative field.

Expected Scientific Skills

- Good command of statistical tools (R or Python).
- Strong background in statistics or epidemiology.
- Prior experience with cohort data analysis.
- Knowledge on environmental data bases or GIS is an asset

Languages

- Working languages: French and English.

Additional Qualities

- Scientific curiosity and enthusiasm for research.
- Autonomy, rigor, and organizational skills.
- Analytical and synthesis abilities, with strong oral communication skills.
- Team spirit and ability to work within a hierarchical structure.
- Scientific writing skills in both French and English.

5. Contract Conditions

- Duration: 36 months.
- Location: Vandœuvre-lès-Nancy / Nancy, France.
- Starting date: from March 2027.
- Salary: €2,300 gross monthly salary (net salary: approximately less than 20% deductions from gross salary).
- Doctoral enrollment: BIOSE Doctoral School – University of Lorraine.

Funding for this PhD project has already been secured.

6. Application Procedure

Required Documents

- CV
- Cover letter
- Master's transcripts
- Master's thesis or scientific article
- Two recommendation letters

Submission Format: PDF format only.

Submission Addresses

- s.wagner2@chru-nancy.fr
- youba.ndiaye@univ-lorraine.fr

Application Deadline
December 11, 2026.

7. Selection Timeline

- Application deadline: December 11, 2026
- Expected interview period: Week of December 16, 2026 or 07 Janurary, 2027
- Expected starting date: From March 2027

8. Contacts

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CIC-P website
BETA website