

THESIS TOPIC

Subject N° (to be completed by the ED):	FUNDING: <input checked="" type="checkbox"/> Requested <input type="checkbox"/> Acquired	Funding origin: Doctoral contract EHESP
Thesis title: Early-life exposure to urban environment and working memory development across childhood and adolescence in European birth cohorts		3 keywords: cohorts, urban environment, neurodevelopment
Unit / team: UMR Inserm 1085 Irset (institut de recherche en santé, environnement et travail) - Equipe 9 ELIXIR (épidémiologie et science de l'exposition en santé environnement)		
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<p>Summary (2000 characters) :</p> <p>Optimal cognitive development in childhood is a major public health challenge in the context of increasing global urbanization. By 2050, more than 70% of the world's population will live in urban areas, facing greater exposure to environmental factors such as air pollution, traffic noise, and limited access to green spaces. These exposures may influence brain development and impair core cognitive functions, particularly working memory, which plays a key role in learning, reasoning, and behavioral regulation. The main goal of this PhD project is to assess the effects of the urban environment on children's and adolescents' working memory, and to identify the brain mechanisms involved. The project will draw on longitudinal data from three European birth cohorts (PELAGIE and SEPAGES in France, and INMA in Spain), which include a wide range of environmental exposures measured from pregnancy, repeated assessments of cognitive function, and brain imaging data (resting-state and task-based MRI focused on working memory). The first phase of the thesis will involve bibliographic research, followed by data harmonization and statistical analyses. Three scientific articles are planned: (1) associations between early-life urban exposures and working memory development at multiple ages; (2) links between urban exposures and functional brain connectivity in adolescence; and (3) associations between urban exposures and working memory-related brain activity in childhood. The analyses will include single-exposure models and exposome-based approaches accounting for co-exposures (e.g., penalized regression, clustering methods). This research is embedded within an international consortium and conducted under a One Health research chair, at the intersection of environmental epidemiology, neuroscience, and urban policy.</p>		
<p><u>Socio-economic and scientific context (approximately 10 lines):</u></p> <p>Over 50% of the global population currently lives in urban areas—a figure projected to reach 70% by 2050, according to the United Nations. While urban living improves access to essential services (education, healthcare, employment), it also increases exposure to harmful environmental factors such as air pollution, road traffic noise, and reduced availability of green spaces. Neurodevelopment, which begins in early gestation and continues into adulthood, is highly plastic and sensitive to early environmental insults. Among the affected cognitive functions, working memory plays a central role in intelligence, learning, and behavioral regulation. Several epidemiological studies have identified associations between air or noise pollution and impaired cognitive function in children. However, these exposures are often studied in isolation, without accounting for their potential interactions. The urban exposome approach—which considers all environmental exposures related to urban living simultaneously—remains underutilized in longitudinal studies on brain development. Better understanding these complex interactions is essential to identify effective intervention strategies, guide urban policy, and support optimal cognitive development.</p>		
<p><u>Working hypothesis and aims (approximately 8 lines):</u></p> <p>The central hypothesis of this PhD is that early-life exposure to the urban environment may influence working memory development in children through changes in brain function.</p> <p>The overall objective is to investigate the effects of several urban environmental exposures (air pollution, traffic noise, and green space access) during pregnancy and childhood on the development of working memory. The project will leverage longitudinal data from three European cohorts: PELAGIE and SEPAGES (France), and INMA (Spain). These cohorts provide the opportunity to explore neurodevelopmental trajectories across diverse environmental and socioeconomic contexts, with detailed urban exposure data from pregnancy through adolescence, repeated assessments of working memory, and MRI-based brain function measurements (resting-state and task-based) during childhood and adolescence.</p>		
<p><u>Main milestones of the thesis (approximately 12 lines):</u></p> <p>The first phase of the PhD will involve a comprehensive literature review, followed by data harmonization across the three cohorts, and then statistical analyses, interpretation, and dissemination of findings via conferences and peer-reviewed publications.</p> <p>The three planned articles are:</p> <ul style="list-style-type: none"> Article 1: Examine associations between early-life urban environment and working memory development at different ages of childhood and adolescence in the PELAGIE, SEPAGES, and INMA cohorts, using longitudinal mixed models to account for repeated cognitive assessments. Article 2: Assess associations between early-life urban environment and adolescent brain functional connectivity in the INMA cohort. This study will also explore whether brain connectivity mediates the association between urban exposures and working memory. Article 3: Investigate associations between early-life urban exposures and working memory-related brain activity in childhood in the PELAGIE and SEPAGES cohorts. This analysis will also consider the potential mediating role of brain activity in the association between environment and working memory. <p>Analyses will evaluate the individual effects of each urban factor, adjusting for potential confounders, and will also apply multi-exposure approaches (e.g., penalized regressions, clustering methods) to assess the impact of exposure mixtures.</p>		
<p><u>Scientific and technical skills required by the candidate (2 lines):</u></p> <p>The candidate should have a background in epidemiology, biostatistics, neuroscience, or a related field; strong proficiency in statistical software (R, SAS); solid analytical and problem-solving skills; and a very good command of English. Experience in environmental health, exposome</p>		

research, or maternal-child health would be a plus.

3 publications from the team related to the topic (last 5 years):

- Binter, A.-C., Granés, L., Bannier, E., de Castro, M., Petricola, S., Fossati, S., Vrijheid, M., Chevrier, C., El Marroun, H., Nieuwenhuijsen, M., Saint-Amour, D., Tiemeier, H., Guxens, M., 2024. Urban environment during pregnancy and childhood and white matter microstructure in preadolescence in two European birth cohorts. Environ. Pollut. 346, 123612. <https://doi.org/10.1016/j.envpol.2024.123612>

- Crooijmans, K.L.H.A., Iñiguez, C., Withworth, K.W., Estarlich, M., Lertxundi, A., Fernández-Somoano, A., Tardón, A., Ibarluzea, J., Sunyer, J., Guxens, M., Binter, A.-C., 2024. Nitrogen dioxide exposure, attentional function, and working memory in children from 4 to 8 years: Periods of susceptibility from pregnancy to childhood. Environ. Int. 186, 108604. <https://doi.org/10.1016/j.envint.2024.108604>

- Zare Sakhvidi MJ, Yang J, Lequy E, Chen J, de Hoogh K, Letellier N, Mortamais M, Ozguler A, Vienneau D, Goldberg M, Zins M, Berr C, Jacquemin B. Outdoor air pollution exposure and cognitive performance: findings from the enrolment phase of the CONSTANCES cohort. Lancet Planet Health 2022. 6: e219–29

National and international collaborations:

This PhD is part of the "Epidemiology and Modeling for One Health" research chair, co-supervised by its chairholder, and fosters close collaboration with the French Agency for Food, Environmental and Occupational Health & Safety (Anses). It is also embedded in the UNEVEN project (funding request submitted to Anses), which brings together an international consortium of two French teams and cohorts (PELAGIE, SEPAGES) and one Spanish team and cohort (INMA). This collaborative setting provides a unique opportunity to conduct innovative research at the intersection of environmental epidemiology, neuroscience, and neuroimaging, in a dynamic international environment.