

Project Details	
Project Code	NMH27Ex HZhang
Title	Air Pollution, Heat and Other Environmental Exposures in Relation to Cognitive Ageing: A Longitudinal Cohort Study
Research Theme	Neuroscience & Mental Health
Project Type	Dry lab
Summary	How do the environments we live in influence how our brains age? This PhD will use the PROTECT study, a large UK online cohort with repeated cognitive assessments, to investigate whether long-term exposure to outdoor air pollution, heat and other environmental exposure are associated with cognitive decline in later life. The student will link environmental exposure data to longitudinal cognitive and health outcomes, identify vulnerable groups, and explore how different exposure windows shape results. The project offers training in exposure science, environmental epidemiology, cognitive ageing, and longitudinal data analysis.
Description	Evidence has been rapidly accumulating between ambient air pollution and incidence of dementia. However, compared to established outcomes such as cardiovascular and respiratory diseases, the contribution of environmental factors to cognitive ageing remains less established. Understanding remains limited on which exposure periods matter most, why rate of cognitive decline differ, which cognitive domains may be most affected, and whether some population groups are more vulnerable than others. After reviewing nearly 70 papers, the Committee on the Medical Effects of Air Pollutants (COMEAP) in 2022 tentatively concluded air pollution is likely to contribute to cognitive decline and dementia. COMEAP then suggested to look at both particulate and non-particulate pollution (e.g. NO₂, O₃) using existing UK cohorts over a longer period and longitudinal studies including multiple cognitive testing (1). The Platform for Research Online To Investigate Genetics and Cognition & Ageing (PROTECT) study provides a valuable opportunity to address these questions. PROTECT is a large UK longitudinal online cohort designed to investigate brain health, cognition, ageing and dementia risk. Participants complete repeated cognitive assessments and questionnaires covering health, lifestyle, mental health and demographic factors on annual basis. These repeated measures allow researchers to move beyond one-off comparisons of cognitive performance and examine how cognition changes within individuals over time. This makes PROTECT well suited to studying whether air pollution and other environmental exposures are associated with trajectories of cognitive ageing. This PhD will link PROTECT participants to longitudinal outdoor environmental exposure data, using residentially derived geographical information under appropriate data governance and ethical approval. The project will focus on ambient air pollution and heat, including exposures such as PM_{2.5}, NO₂, O₃, annual and seasonal temperature, hot days, hot nights and heatwave indicators. Additional socioenvironmental factors such as green space, noise, ambient light, housing EPC level, and deprivation would be incorporated to understand environmental and social inequalities in cognitive ageing.

	The overarching research question is: Are long-term exposure to outdoor air pollution and heat associated with faster cognitive decline among adults in the PROTECT cohort? If yes, which domain of cognitive trajectories it affects the most? The student will work towards four linked objectives. Objective 1: Develop longitudinal environmental exposure measures for PROTECT participants. The student will work with the supervisory team and PROTECT data custodians to derive annual, seasonal and lagged exposure metrics for ambient air pollution and other environmental exposures. This may include PM2.5, NO2, mean temperature, hot days, cold days, heatwave indicators, noise, housing EPC level, and ambient light, with a focus on ambient air pollutants. The student will compare different exposure windows, such as same-year exposure, previous-year exposure, multi-year average exposure, childhood exposure and season-specific heat exposure. Objective 2: Characterise cognitive and health trajectories in PROTECT. The student will identify suitable repeated cognitive outcomes, including domain-specific measures such as memory, attention, reaction time, vigilance or other available cognitive scores. They will also consider relevant health and wellbeing outcomes, such as sleep, mental health, self-reported health or functional measures, where available. Under this objective, the student will establish how cognitive performance changes over follow-up and how these changes vary by age, sex, education, health status and socioeconomic context. Objective 3: Examine associations between environmental exposures and within-participant cognitive change. Using longitudinal statistical methods such as mixed-effects models and more advanced machine learning methods, the student will examine whether higher exposure to air pollution is associated with faster cognitive decline. Both single-pollutant and multi-pollutant model will be employed to test the association. The project will distinguish cross-sectional differences in cognitive performance from within-participant change over time. Analyses will adjust for key confounders, including demographic, lifestyle, health and socioeconomic factors. The student will also explore whether associations differ across cognitive domains and exposure windows. The student will investigate whether environmental associations are stronger in specific groups, such as older participants, people with lower socioeconomic position, lower educational attainment, poorer baseline health, sleep problems, mental health symptoms or higher genetic risk, depending on data availability. Once the vulnerable group were identified, targeted intervention would be proposed to improve the health and wellbeing of the vulnerable groups. Objective 4: Identify vulnerability and assess target interventions. The student will have substantial scope to shape the project. They may choose to focus more strongly on air pollution, heat, or combined environmental burden; select priority cognitive domains; develop inequality-focused analyses; or compare alternative exposure windows. The student will benefit from training and supervision expertise in environmental epidemiology, cognitive ageing, longitudinal cohort
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	analysis, exposure assessment, and spatial data linkage. It will generate new epidemiological evidence on whether outdoor air pollution contribute to cognitive ageing and identify opportunities, and presents possibilities for new intervention for air quality and healthy ageing, in the context of climate change. 1. COMEAP. Air pollution: cognitive decline and dementia. London; 2022 Jul 25. https://www.gov.uk/government/publications/air-pollution-cognitive-decline-and-dementia
Can be completed part time?	Yes
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