Overview of the International Scientific Advisory Board 2020/21 Annual Reports

MRC Centre for Environment & Health
Medical Research Council
Imperial College London

NIHR | Health Protection Research Unit in Environmental Exposures and Health at Imperial College London

NIHR | Health Protection Research Unit in Chemical and Radiation Threats and Hazards at Imperial College London

Foreword

In the following three reports we present highlights of the ongoing activities, achievements and future plans for the MRC Centre for Environment and Health (incorporating the UK Small Area Health Statistics Unit), the NIHR Health Protection Research Unit (HPRU) in Environmental Exposures and Health and the NIHR HPRU in Chemical and Radiation Threats and Hazards. The co-location of these entities, all based in the School of Public Health at Imperial College London, has been made possible by major investment by Imperial College both in the transfer of Prof. Frank Kelly's Environmental Research Group from King's College London to Imperial in July 2020, and the provision of new laboratory and office space on Imperial's new White City campus (see below). This represents by far the largest grouping of researchers working on environment and health in the UK.

The MRC Centre and the two HPRUs address specific but highly complementary aspects of research on the health effects of environmental hazards. They bring together partners from Imperial College London, Public Health England (PHE)/ UK Health Security Agency (UKHSA), King's College London and the MRC Toxicology Unit at the University of Cambridge, and their own wider networks of collaborators. Together these form a highly integrated research network with a coherent and comprehensive research programme on environment and health, from exposure science, to laboratory and population studies, through to health protection research and its translation into policy and practice. In addition to the research, the MRC Centre and two HPRUs have a strong focus on training, particularly at PhD and post-doctoral level, and strongly support outreach, public engagement and participation.

To take best advantage of the opportunities afforded by the bringing together and co-location of these entities, we have integrated their core management and operational structures, through the creation of joint committees overseeing the training, public engagement and knowledge mobilisation cross-cutting activities, a joint International Scientific Advisory Board and joint Public and Community Advisory Group. However, we have retained separate senior governance strategy and decision-making structures for the MRC Centre and the two HPRUs, the Centre's Steering Committee and the HPRUs Joint Steering Committee, to ensure the specificity of each of their research and associated programmes and appropriate governance procedures.

We decided to present the activities of the MRC Centre and the two HPRUs in three separate reports, to facilitate their review and allow the assessment of progress against their specific objectives. This has however inevitably led to a degree of overlap and duplication, particularly in the cross-cutting areas whose activities are now fully integrated.

We are excited for the future - taking advantage of the combination of the range of expertise and critical mass across the various partners, with the co-location of the three entities under one roof in dedicated, state-of-the art, office and laboratory facilities in the new White City campus.

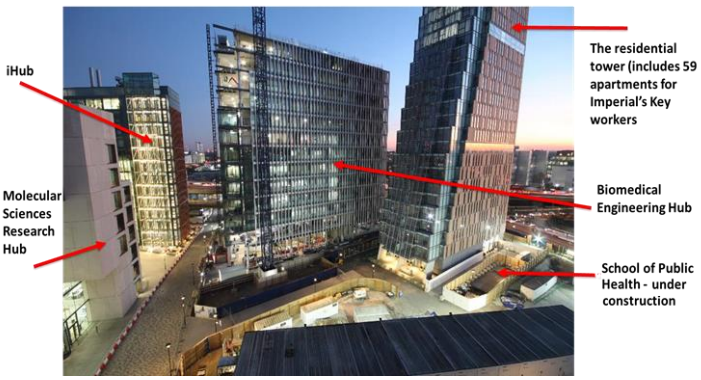

Fig 1. Imperial College's new White City Campus. The MRC Centre and two HPRUs are co-located over two floors in the Biomedical Engineering (Uren) building.

Moreover, we are excited by the potential to be at the forefront of the MRC's proposed strategy to establish Centres of Excellence with significantly increased funding and duration beyond the standard Centre model. We have already initiated discussions with the MRC concerning this possibility as we approach the Centre's mid-term review.

This expanded scope, together with the continued development of the collaborations with partners in the Centre and HPRUs, presents a unique opportunity to build on our successes to date and further develop and consolidate our position as a leading research and training hub addressing some of the major environment and health challenges of our time.

Introduction to the MRC Centre for Environment and Health

Partners: Imperial College London (Department of Epidemiology and Biostatistics; Environmental Research Group; National Heart and Lung Institute)

Since its creation in 2009, the MRC Centre has established itself as the *de facto* 'go to' Unit in the UK for research, training and policy advice on environment and health, with a focus on air pollution, noise, non-ionising radiation, small-area health studies, and the '*exposome*'. In 2019 the Centre was awarded funding by the MRC for a third quinquennium (01 July 2019 to 30 June 2024).

The mission of the MRC Centre for Environment and Health is to undertake the highest quality research to advance understanding of the effects of key environmental hazards with a significant impact on human health and wellbeing. The Centre's research aims to:

i. identify novel associations between environmental exposures and adverse health outcomes;
ii. quantify the risk of environmental exposures on health at both the individual (*exposome*) and population level;
iii. produce new insights into possible mechanisms and causal associations;
iv. provide high-quality, multidisciplinary training in quantitative sciences to form the next generation of research leaders in environment and health;
v. inform the development and targeting of interventions and policies to protect public health.

The Centre's research combines advanced quantitative methods in exposure monitoring and modelling, omics, toxicology, epidemiology, biostatistics and computational biology, with the collection of large environmental and health datasets and the curation of large cohorts with deep phenotyping and biological sample collections. It incorporates the UK Small Area Health Statistics Unit (SAHSU) combining expertise in spatial epidemiology and access to routinely collected health and population data for high-resolution disease mapping and risk analyses.

This combination of multi-disciplinary expertise and access to extensive data resources underpins the Centre's distinctive research strategy, working both forward and backward from the molecular to the individual and to the population level to strengthen causal inference.

Significant achievements to date include: i) we delivered a range of research activities using mobile and static environmental sensors to assess hyperlocal and individual environmental exposures and the London Hybrid Exposure Model has been enhanced to cover the whole of the UK, ii) we developed methods to separate personal exposure measurements into components relating to outdoor sources and indoor sources and developed methods to identify the presence of inhalable microplastics, iii) we investigated the molecular signatures associated with socioeconomic and lifestyle exposures in order to understand the biological pathways leading to poor health in mid- to later life, as well as to identify key influences on healthy aging, iv) we used ultra-high-resolution mass-spectrometry to agnostically screen for exogenous chemicals in 10,000 blood samples of cohort study members, studying the evolution of the *exposome* and health through the life course, v) we mapped open and green space for all schools in London and are mapping traffic safety in areas around schools and are conducting similar activities in Accra, Beijing and Dhaka, vi) we examined the impacts of the COVID-19 pandemic on population health in a data driven approach, eliciting features of communities with higher/lower infection.

Introduction to the NIHR Health Protection Research Unit in Environmental Exposures and Health at Imperial College London

Partners: Imperial College London, PHE/UKHSA, King's College London and University of Cambridge.

The Environmental Exposures and Health (EEH) HPRU is a successor to the successful Health Impacts in Environmental Hazards HPRU led by King's College London that ran from 2014 to 2020. With the transfer of its Director Prof Frank Kelly to Imperial College the EEH HPRU has also moved to Imperial.

Like its predecessor, it will provide high quality scientific evidence to support PHE/UKHSA[1] in implementing effective public health interventions to reduce the burden of ill health.

This HPRU continues work on some of the major environmental impacts on health in the UK. Continued are activities in air pollution (out and indoor), nanomaterials, illicit drugs and bioaerosols. New to this EEH HPRU are some emerging areas such as microplastics, e-cigarettes, waste fires and perfluorinated chemicals. Fronting this work is biomonitoring to assess exposure both of humans and the environment including through wastewater assessments. These activities are mutually supporting and derive equal effort and expertise from Imperial and PHE/UKHSA demonstrating the value of the HPRU to the UK research base and policy arena in this area.

Our outcomes will be: i) identification of existing and emerging environmental hazards, ii) quantification of risk to human individuals and populations utilizing assessment of hazard and exposure, iii) further the understanding of biochemical pathways and toxic properties of such environmental contaminants and development of *in vitro* models, iv) identification of the populations and individuals at greatest risk so that interventions (including prevention policies and treatments) can be appropriately targeted and v) response to emerging issues.

Significant achievements to date include: i) we completed two pieces of responsive work covering the effects of public transport use on air pollution during the pandemic and e-cigarette co-exposures, ii) we undertook work on birth outcomes, impacts on mental health and dementia, as well as the planned evaluations of the impacts of the introduction of London's Ultra Low Emission Zone all of which have major public health ramifications, iii) we established a bioaerosol surveillance program to underpin future health studies.

Introduction to the NIHR Health Protection Research Unit in Chemical and Radiation Threats and Hazards at Imperial College London

Partners: Imperial College London, PHE/UKHSA, King's College London and University of Cambridge.

The Chemical and Radiation Threats and Hazards (CRTH) HPRU is a new venture for Imperial College won by competition following on from a similarly named Unit held by the University of Newcastle in the first phase of the HPRUs. The CRTH HPRU aims to generate high quality scientific evidence to support PHE/UKHSA in implementing effective public health interventions to reduce the burden of ill health, ensure effective protection of the population and to mitigate health inequalities from these exposures.

The mission of the CRTH HPRU is to undertake the highest quality research on the health effects of exposures to hazardous chemicals and radiation to improve their assessment, management and control. Our aim is to gain new knowledge on the distribution, determinants, mechanisms and pathways linking these exposures to health effects and to advance our understanding of how the everyday and exceptional contact we have with chemicals and radiation leads to ill health. In this way we aim to strengthen the scientific evidence underpinning public health practice and policy.

The work of the CRTH HPRU is organized around four Themes considering hazards such as ionising radiation, electromagnetic fields, ultra-violet light, re-developed brownfield sites, neurotoxins and other high-toxicity chemical agents and drinking water contaminants.

Significant achievements to date include: i) results of analyses of childhood cancer near nuclear installations presented to the Committee on Medical Aspects of Radiation in the Environment to inform radiation protection policy, ii) identification of a two-phase response to the effects of ultraviolet light on nitric oxide production in skin cells suggesting that the vasodilatory effect may operate over a longer time-scale than previously thought, extending beyond the time of direct exposure, iii) work on detection of the production of 'homemade' chemical threat agents through analyses of municipal wastewater, providing new capability to identify imminent chemical threats to the public - this work has produced a new database of the chemical composition of several high-priority homemade explosives that is now used by the UK Intelligence Community.

[1] Public Health England will transition to a new agency, the UK Health Security Agency, from October 1, 2021.