[Applicant name redacted]
Clark & Cummins & Gulliver project
Estimating the impact of urban environmental exposures on trajectories of child and adolescent mental health

I have worked together with the supervisory team and built on the available Project Summary to develop this research proposal further.

Title:
Estimating the impact of urban environmental exposures on trajectories of child and adolescent mental health

Hypothesis:
The presence of urban environmental exposures, in particular noise, increases the likelihood of the development of mental health conditions in children and adolescents.

Background:
The quality of the outdoor environment plays a large role in protecting and promoting public health. Urban environments can influence health outcomes through a variety of factors and exposures. They play a role in the development of many health conditions and processes, including mental health, wellbeing, childhood development, cognitive functioning, cardiovascular and respiratory health, and obesity.

As there is a greater demographic transition worldwide to urban areas and the proportion of the population in urban areas is steadily increasing, the impact that urban environmental exposures are having on population health is also increasing.

Urban noise exposures affect many millions of people across the UK. Data from the European Environment Agency (2020) indicate that the number of people exposed to high levels of noise from road traffic is 9.5 million, railways is 1.2 million and airports is around 1 million.

The mechanisms for noise exposures on health are being researched but are still unclear - but some potential pathways include psychosocial stress and poor sleep. Additionally these exposures can trigger biological responses, which result in an increase in stress hormone levels and allostatic load. If triggered over a long period of time, this can lead to conditions such as diabetes, strokes and cardiovascular events (such as myocardial infarctions/heart attacks) through raised blood pressure and increased blood sugar and fat levels.

In the UK, noise exposures have been associated with 1000 premature deaths, 6000 cases of heart disease and 750 000 cases of sleep disturbance (European Environment Agency, 2020). Sleep disruption has been linked to biologic proinflammatory responses and upregulation of the sympathetic nervous system, which can also pose a risk for cardiovascular outcomes, diabetes and weight-related health conditions (Medic et al, 2017).

There is a steadily increasing amount of current literature that establishes the relationship between environmental noise annoyance and poor mental health outcomes (Hammersen F et al, 2016). However, this evidence base still contains many crucial gaps. In particular, there is a lack of longitudinal data investigating noise exposures and mental health outcomes. Longitudinal studies are key for providing evidence of temporality and hence causality; and the data and analyses from this type of study will be better equipped to assess the relationship in more detail.

There is also a lack of evidence on the effects of different environmental noise sources (e.g. road, rail and aircraft); exposure in different settings (e.g. home, school and neighbourhood); during the day vs night; and for different mental health and wellbeing outcomes.

Noise is just one of many pervasive environmental exposures, however. These include air pollution, access to greenspace, housing quality, neighbourhood amenities and layout, and spatial planning of food outlets (including fast food). The association between air pollution and health has been highly investigated and quantified. However, data on the relationship between these other environmental exposures and health is lacking in comparison. These associations have been poorly quantified, and many papers still cite these associations as spurious. This is often due to poor data availability and a lack of effective models in this area. Additionally, there is limited evidence about the inequitable health outcomes of these exposures, and the specific population groups that are affected.

The lack of evidence for these pollutants limits the development of policies and urban design guidelines. This research would inform mitigation policies, which would help to contribute to many long-term public health improvements.

Consensus statements from the recent House of Lords Science and Technology inquiry have identified environmental noise as a 'neglected pollutant'. They have called for further research on the effects of noise, to aid policy making, help to reach government targets for environmental exposure regulation and to reduce inequalities.

This study aims to contribute to this evidence gap to strengthen policy making in this highly topical area of public health. It aims to apply social, health and environmental science to the problem of a range of environmental pollutants on public mental health outcomes.

Objectives of the study:
Investigate how the environmental exposures of noise, greenspace access, housing quality and neighbourhood spatial planning (including availability of amenities and fast-food outlets) influence the trajectories and development of mental health
conditions over time. This project will take an interdisciplinary approach looking at multiple levels.

- Modelling environmental exposures at the population level and mapping local environments, to enable improved quantification of these exposures.
- Examine the association between:
    - Type of noise exposure
    - Exposure in different settings (including school, home and neighbourhood environments)
    - Exposure in different time frames (day vs night)
    - On the outcome of mental health trajectories.
- Investigate how urban design and urban regeneration affect the environmental exposures of greenspace access, housing quality and neighbourhood spatial planning; and how these influence mental health and wellbeing.
- Use longitudinal data to establish temporality and direction of these associations.
- Identify which mental health conditions are the most incident in these associations.
- Aim to influence UK policy, guidance and health impact assessments to protect and promote public health.

Type of study
This study will use longitudinal cohort data from two currently existing data resources. This design will be an efficient way of examining the association to verify that the environmental exposure precedes the outcomes of poor mental health

Methods

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This study will use the following two data resources of cohort-based study populations:

- NIHR funded ORiEL study (Olympic Regeneration in East London)
    - This study uses a cohort of 2254 adolescents from 25 schools in East London (Cummins et al, 2018).
    - It aimed to examine the effect of urban regeneration associated with London Olympics on the physical and mental health of young people in East London.
- CLEVER (Cohort for research into Living EnVironments and hEalth in children) ADRUK-funded e-cohort
    - This e-cohort was generated using linked administrative data, and follows the outcomes of 11 million children in England over time.

These cohorts are of a large scale which provides this study with a high power when conducting analyses of associations. They will provide data on a wide range of outcomes, allowing investigation of different associations within different age groups.

There will be two main methodological aspects to the project - environmental modelling and epidemiological analysis.

The modelling will use these data resources to model environmental noise exposures for the adolescent participants of the ORiEL study, and it will also aim to address residential mobility in the datasets. This links to the ongoing MRC funded Longitudinal Linkage Collaboration. This LLC has estimated a range of exposures (including noise, air pollution and green space) using a common data standard in 24 UK cohorts. This linkage allows the use of many different types of data as an input into the environmental exposure models, which will enable reliable estimates of population exposures to noises in different settings. The environmental exposures of greenspace access, housing quality and neighbourhood spatial layout will also be assessed.

The epidemiological analyses will quantify the effects of environmental exposures on mental health outcomes and provide evidence of their statistical strength. The appropriate multilevel statistical methods that will be used will be defined once the data has been further assessed.

Both the modelling and analytical processes will be used to identify mechanisms of action of environmental exposures on mental health outcomes and isolate any causal processes that may be present. This is a crucial component of the research that could help to shape any future public health and environmental health interventions. The effect measures calculated will be adjusted for all known confounding factors, and any associations found will be assessed against the Bradford Hill criteria for causality, such as temporality and dose-response relationships. The methods will be refined over time, for example if further confounders are identified later on during the research process.

Finally, this quantitative evidence will be used to inform environmental and health impact assessments, planning processes for urban design, UK policy and guidance for children and young people's environments. This lies within the overall aim of promoting mental wellbeing and positive mental health. This process of using the implications of these findings will be carried out alongside DEFRA and UKHSA.

Strengths, weaknesses and ethical considerations of the project
The use of leading MRC LLC environmental modelling methods will aim to reduce different types of biases, including selection bias and information bias. However, modelling is only an estimation method and so the exact time frame of the environmental exposures can be hard to quantify. For the epidemiological analyses, there may be difficulty in identifying all the

potential confounding factors. These can both lead to the calculated effect measures having a degree of uncertainty and inaccuracy.
There may be some ethical and consent issues associated with the use of geographical and environmental linked data in the cohorts. However, there is a low overall ethical risk when conducting this type of modelling. The data to be used exists currently and so this carries a low ethical risk. All ethical approval will be sought from my research institution before any research is carried out.

References

- Cummins S et al, 2018. The effects of the London 2012 Olympics and related urban regeneration on physical and mental health: the ORiEL mixed-methods evaluation of a natural experiment. Public Health Research, 6: 12.
- European Environment Agency, 2020. Environmental Noise in Europe Report
- Medic G et al, 2017. Short- and long-term health consequences of sleep disruption. Nat Sci Sleep. 9:151-161

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