

SPACE: the impact of place on cognitive health

Prof Ruth Hunter
Queen's University Belfast

HRS ATW Meeting
22nd – 23rd August 2023



SPACE

**SUPPORTIVE ENVIRONMENTS FOR
PHYSICAL & SOCIAL ACTIVITY,
HEALTHY AGEING & COGNITIVE HEALTH**

This work was supported by **UK Research and Innovation** [ES/V016075/1]



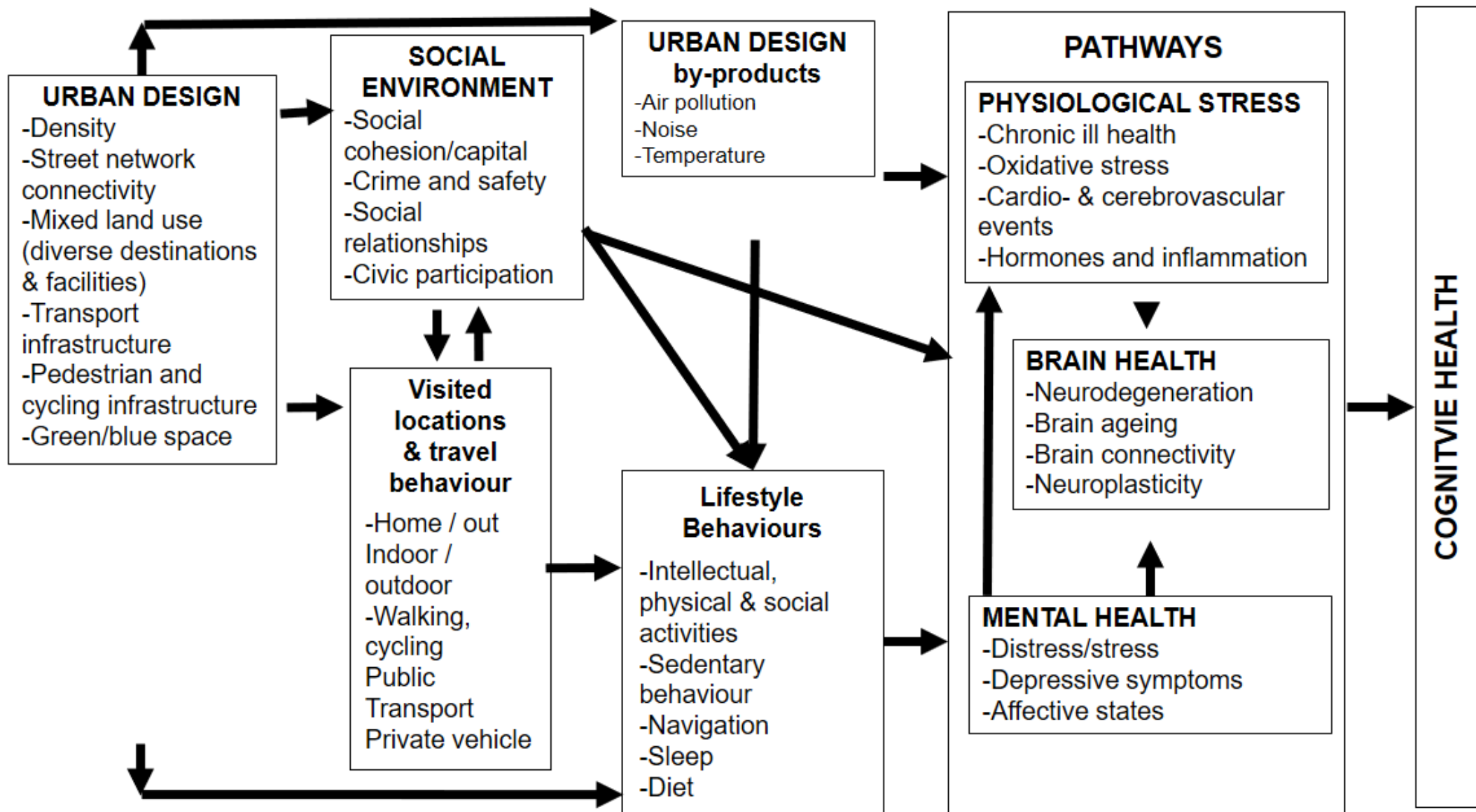


Where we live may influence cognitive health and vulnerability to cognitive impairment

- Key research questions:
 - Are there specific environmental factors that influence cognitive health ?
 - What are the best policies and interventions for promoting healthy ageing and cognitive health for our poorest communities ?
- Aim: To investigate the impacts, and possible mechanistic pathways, of urban environments on cognitive health through the integration of:



- environmental exposures
- lifestyle behaviours
- multi-omics



Other factors: Socio-economic, social, molecular, personality, physical health

Figure 1: Conceptual model of the effects of urban environment on cognitive health (Adapted from Cerin et al, 2020)

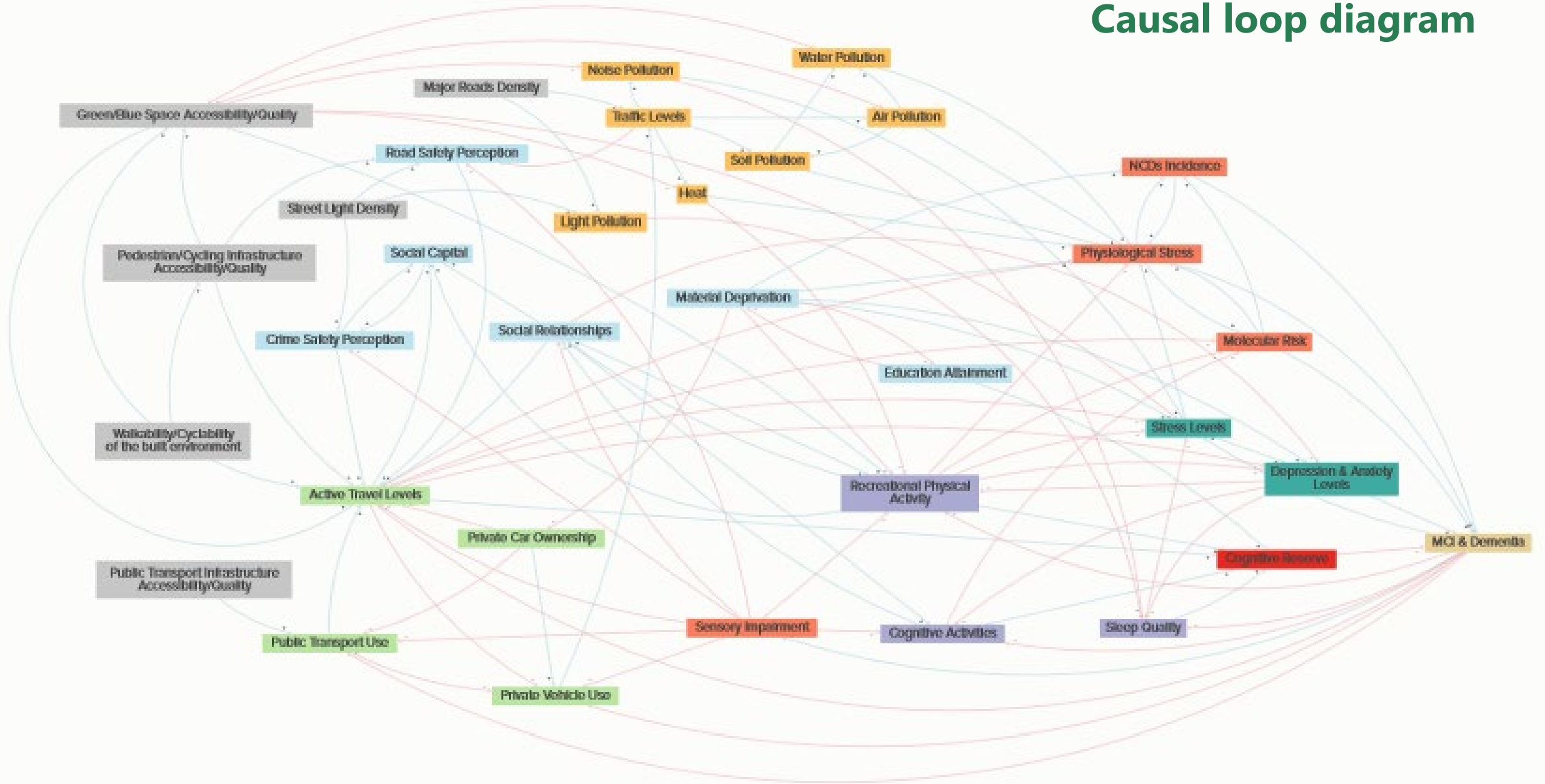


OVERVIEW



1. Systems science approach
2. Spatial environmental data linkage
3. GPS and accelerometry data
4. Biological responses using multi-omic approaches
5. Satellite imagery for creating harmonisable environment data

Causal loop diagram



Interactive Evidence Gap Map



X
6 Records

All
Filter
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Clear Filters

- Exposure
- Air pollution expos...
- Climate
- CO exposure
- Electro magnetic fi...
- Environmental tob...
- Indoor air pollution
- Isophorone exposure
- Lead and mercury ...
- Noise exposure
- NO2 exposure
- NOx exposure
- O3 exposure
- Particulate matter (...)
- Particulate matter (...)
- Persistent organ...

Group by: None

Sort by: Title

A review of epidemiological resear...
Béjot Yannick ; Reis Jacques ; Giroud ...
 2018 ●

Air pollution and Alzheimer's disea...
Fu Pengfei ; Yung Ken Kin Lam;
 2020 ●

Air pollution and cognitive impairm...
Chandra Mina ; Rai Chandra Bhushan...
 2022 ●

Air pollution and dementia: a syste...
Peters Ruth ; Ee Nicole ; Peters Jean ; ...
 2019 ●

Association of air pollution with de...
Tang Jie ; Chen Anthony ; He Fan ; Sh...
 2022 ●

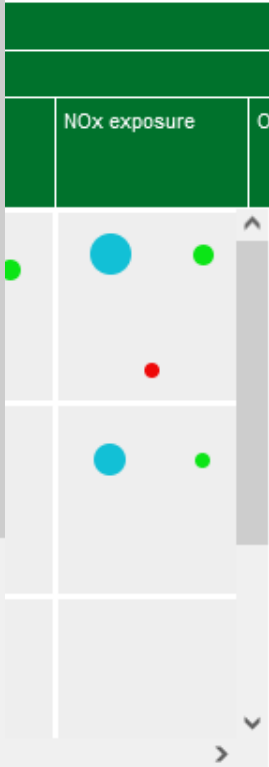
Effect of long-term outdoor air poll...
Tzivian Lilian ; Winkler Angela ; Dlugaj...
 2015 ●

A review of epidemiological research on stroke and dementia and exposure to air pollution

Background Outdoor air pollution is now a well-known risk factor for morbidity and mortality, and is increasingly being identified as a major risk factor for stroke. Methods A narrative literature review of the effects of short and long-term exposure to air pollution on stroke and dementia risk and cognitive functioning. Results Ten papers on stroke and 17 on dementia were selected. Air pollution, and in particular small particulate matter, contributes to about one-third of the global stroke burden and about one-fifth of the global burden of dementia. It particularly affects vulnerable patients with other vascular risk factors or a prior history of stroke in low- and medium-income countries. New pathophysiological mechanisms of the cause-effect associations are suggested. Conclusion Air pollution should be considered

Outcome

- All dementia
- Cognitive impairment
- Child cognitive measures



olution Foundry team.

● Low quality review ● Moderate
 ● Low quality review ● Moderate



Data linkage

- Create and develop spatial environmental data linked to NICOLA
- Investigate joint and independent contributions of urban environments, related environmental exposures and lifestyle behaviours to cognitive health



Environmental Data Linkage

Urban environment data	
Densification	Housing density; population density
Infrastructure	Walkability indices (based on density, land use mix, connectivity, retail plot ratio) for the 500m/1000m hinterlands of the older adult participants in extant cohorts.
Land use	Land use mix; land use type (area and distance to commercial, residential, agricultural, industrial, transport, hospital/medical, educational, 'other land use')
Natural environment	Normalised Difference Vegetation Index (NDVI); access to green space and blue space (water); impervious surfaces
Transportation	Road line, bus stop and train station densities (proxies for air and noise pollution); road speed and traffic collisions
Air, noise and light pollution	Estimates of exposure to ambient air pollution (NO ₂ and PM _{2.5}), noise and light pollution
Soil geochemistry	Urban geochemical data including soil urbanisation tracers (Co, V, Cr, Ni, Zn, Sn, Pb, Sb, As and Mo)**



Extreme heat warning - information and advice

Date published: 20 July 2021

The Met Office has issued an amber weather warning for extreme heat as hot conditions will continue across Northern Ireland this week. Extreme heat can have health consequences, as well as increased traffic near coastal areas, increased use of water and an increase in wildfire risk.



Climate change

- **Heat** (and cold) waves
- Meteorological data
- **Flooding**
- UVA and sun exposure
- Drought and humidity
- **Forest fires and wildfires**





Multi-omics data

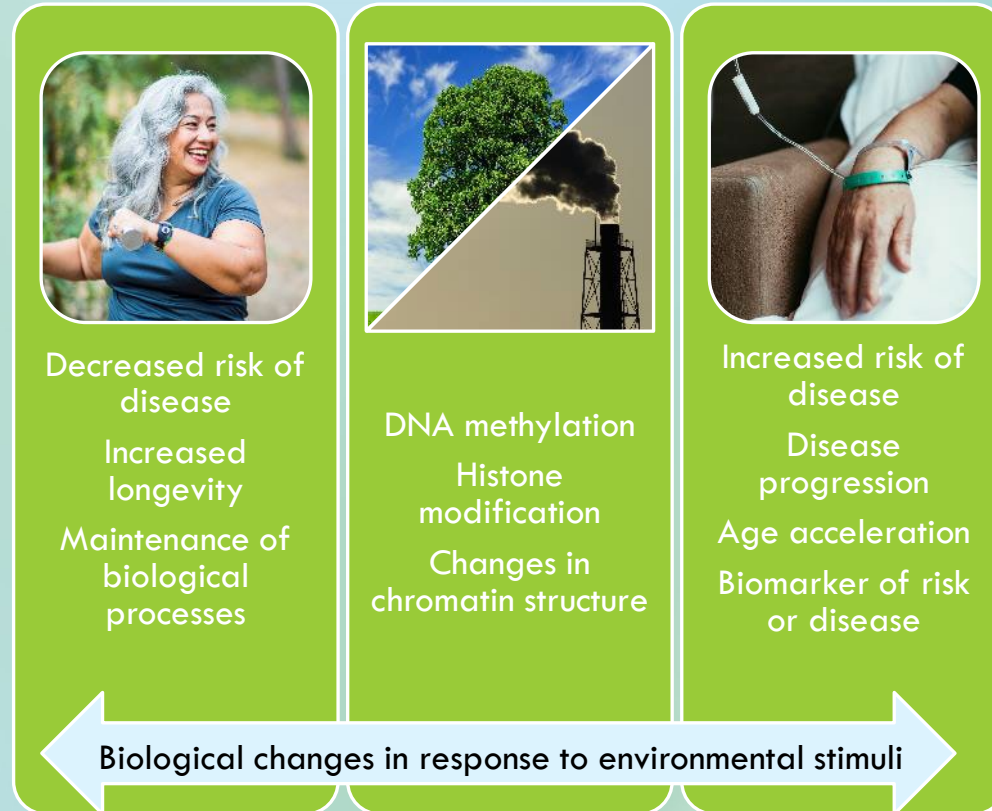
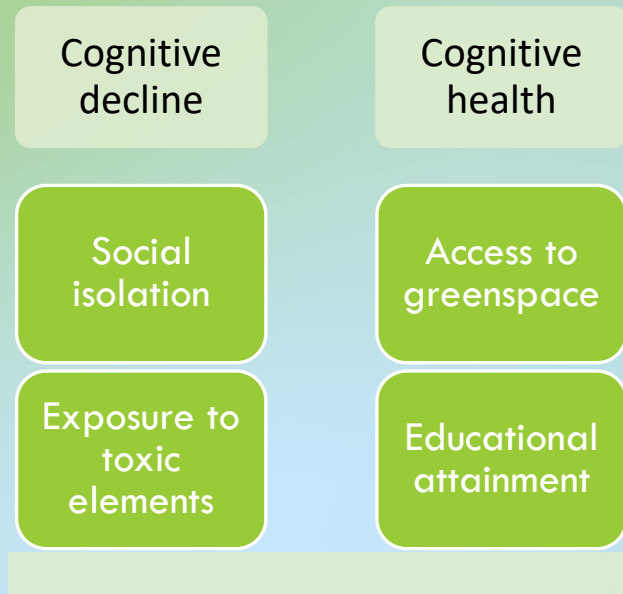
To investigate the biological responses to urban environments and related environmental exposures that influence measures of cognitive health, using multi-omic approaches





OUR HEALTH IS LINKED TO THE ENVIRONMENT where we are born, live, and work

How do external environment associate with epigenetic changes which leads to adverse health effects?

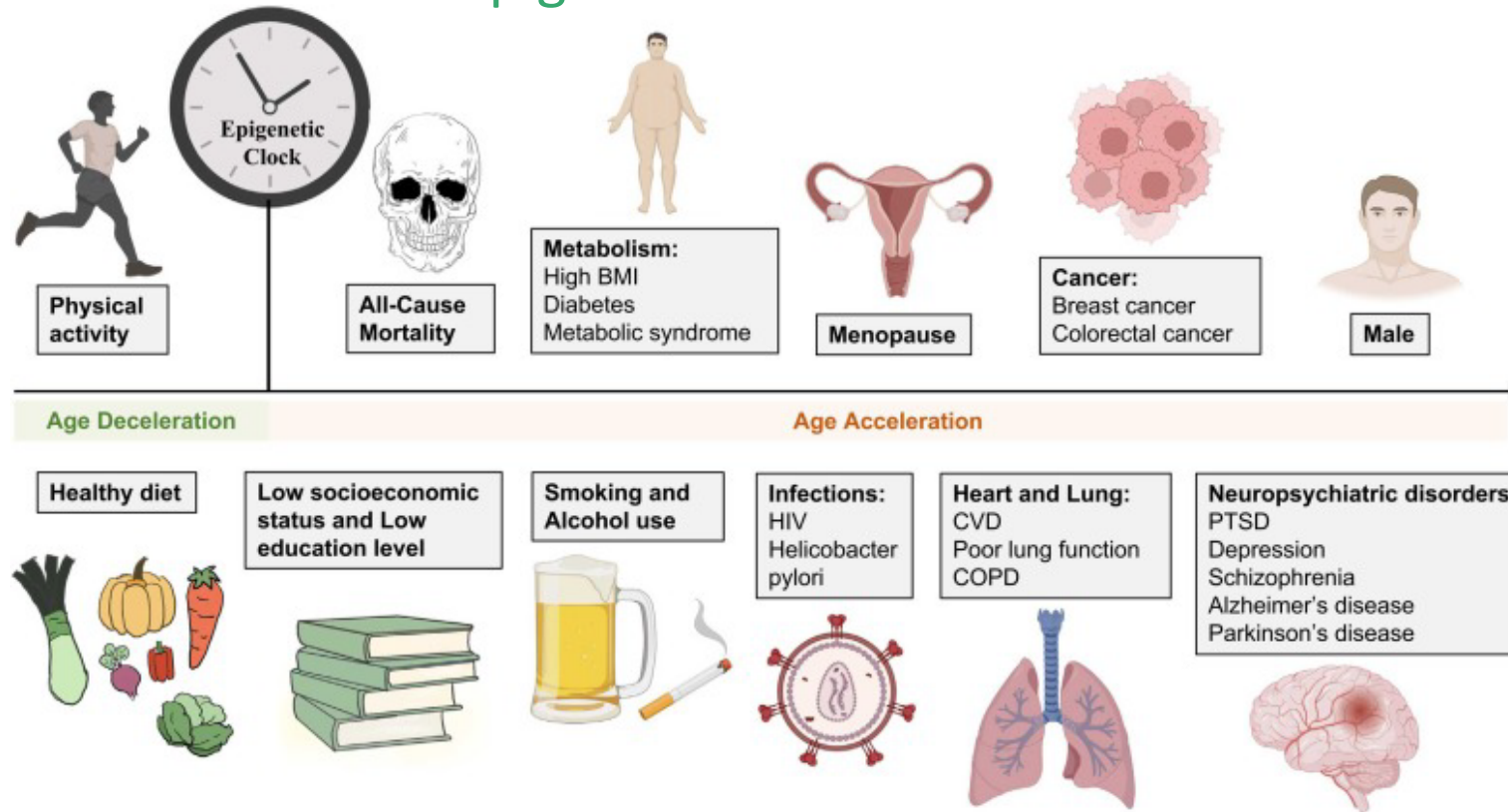


Epigenetic changes (DNA methylation) can be risk factors or protect against disease...**some damage is reversible!**



Eleven epigenetic clocks are now generated for NICOLA, both PCA adjusted and the original clocks -> being run for environmental phenotypes & health related outcomes.

Epigenetic Clock

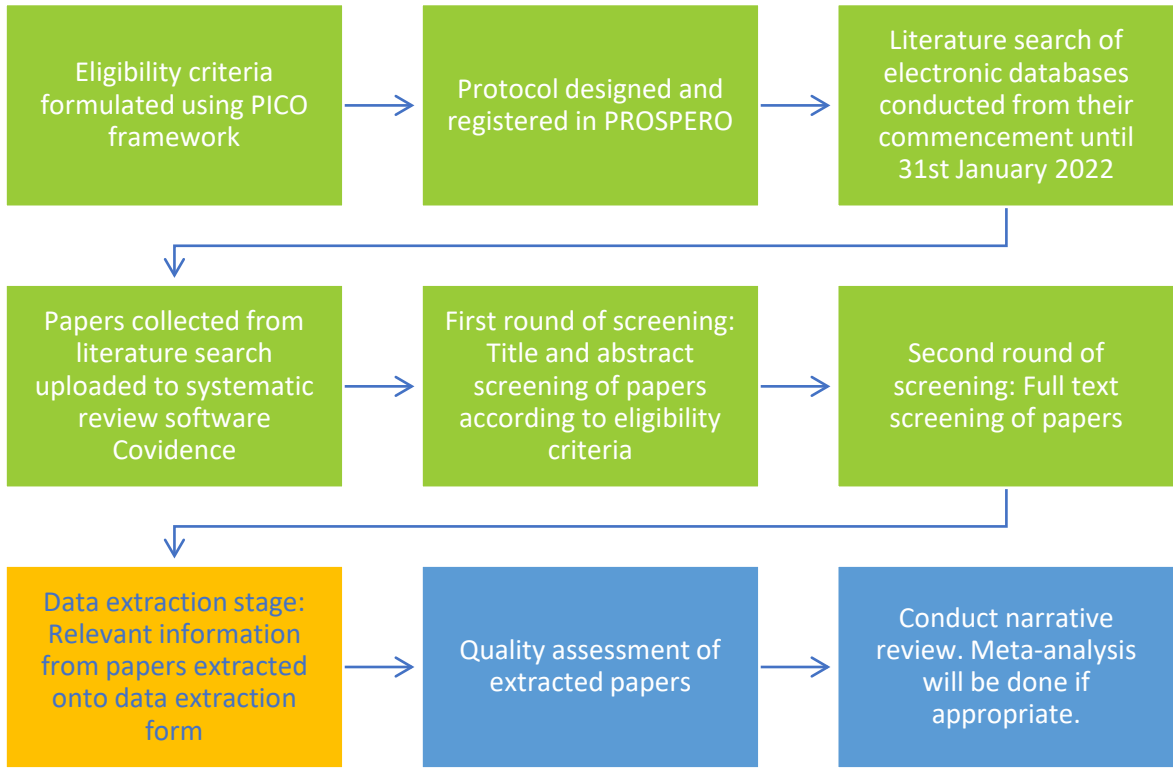


PMID: 36206857

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Systematic review: Environmental exposure and associate genetic/epigenetic changes with adverse health effect



63,810 papers identified from the literature search of electronic papers,

2,845 papers passed title and abstract screening,

794 papers are in data extraction.



GPS and accelerometer data



HHS Public Access

Author manuscript

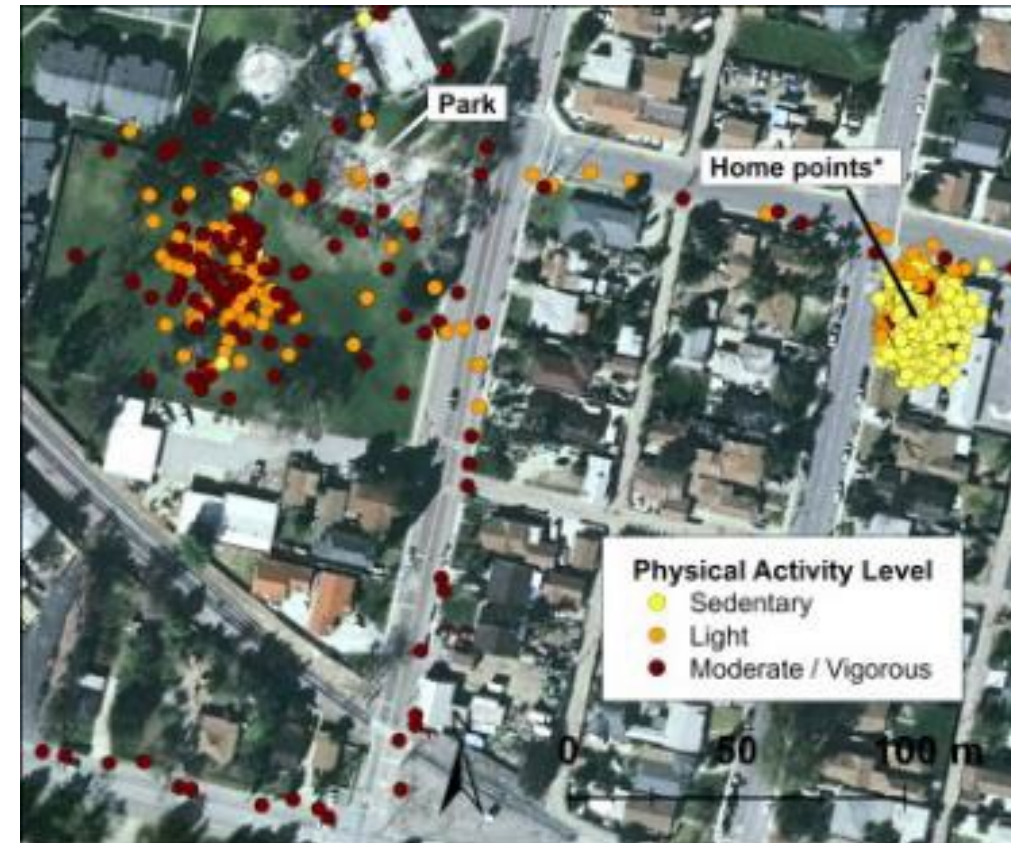
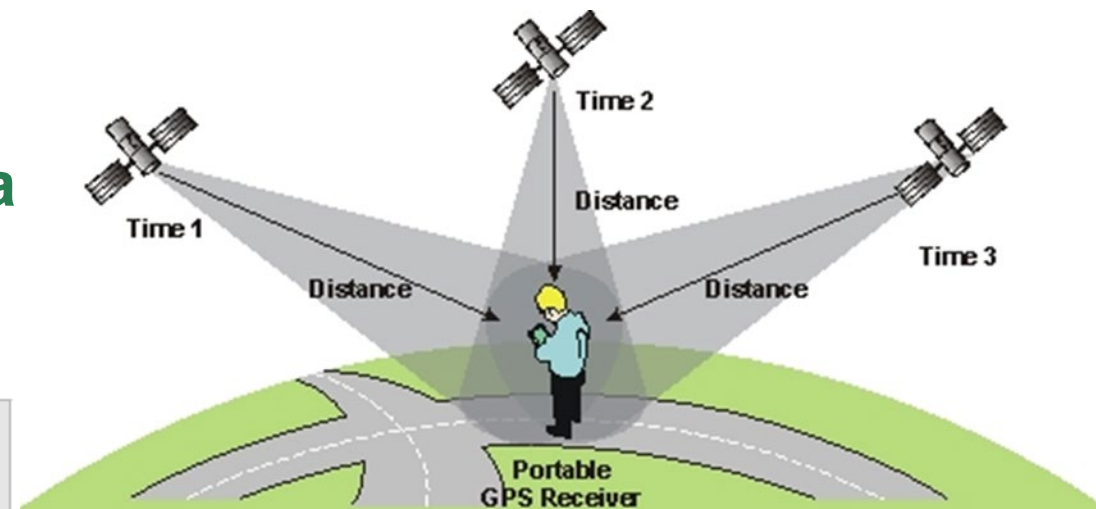
Neuroepidemiology. Author manuscript; available in PMC 2021 January 01.

Published in final edited form as:

Neuroepidemiology. 2020 ; 54(1): 64–74. doi:10.1159/000503004.

The Health and Retirement Study Harmonized Cognitive Assessment Protocol (HCAP) Project: Study Design and Methods

Kenneth M. Langa^{a,b,c,d,*}, Lindsay H. Ryan^c, Ryan McCammon^c, Richard N. Jones^e, Jennifer J. Manly^f, Deborah A. Levine^{a,d,g}, Amanda Sonnega^c, Madeline Farron^a, David R. Weir^c



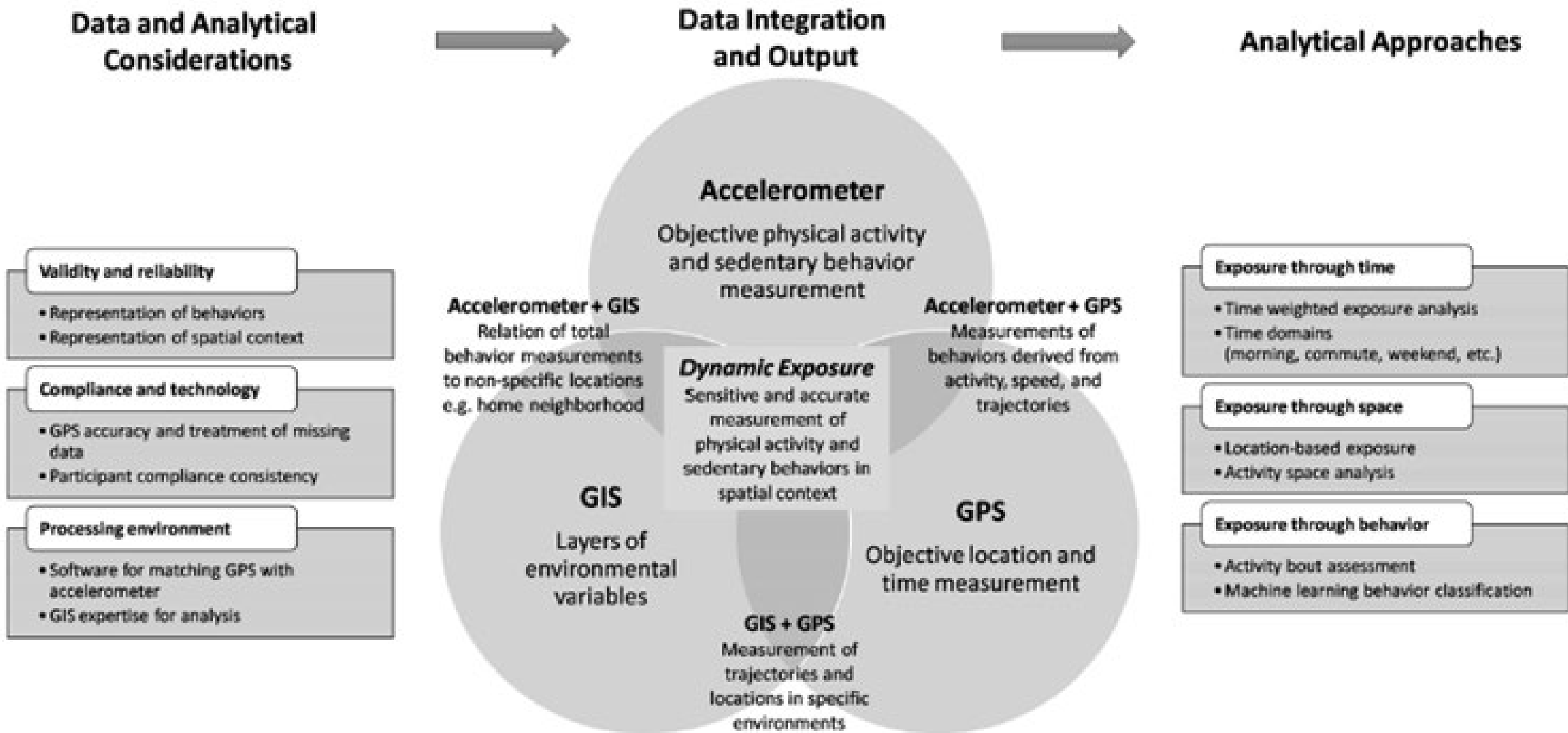


Figure 2.
Framework for integration of GPS, accelerometer, and GIS technology.



Satellite imagery data

- Facilitates at scale
- standardised metrics at scale
- Pipeline design
- Building a machine learning model which can identify high quality green space





Policy and practice



- Cognitive health lacking on the policy agenda
- Addressing the root causes of poor-quality environments will have benefits across a range of policy areas

Addressing:

Poor transport infrastructure,
absence of good-quality
green space, poor housing



Will impact:

Ageing, health, cognitive
decline, liveable communities,
environment, climate crisis

- Agreed set of policy recommendations for how to achieve success in this issue
- White paper that can be used to support local action
- New collaborations, raised awareness of issue etc.
- Practice-oriented outputs – policy briefs, evidence summaries etc



SPACE geoportal



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SPACE Geoportal


For Health and Environment Research, Policy and Action


The SPACE project is investigating factors in the environment that may influence health as we age. This hub is a platform for exploring and downloading Geographic Information Systems (GIS) data relating to that research. In this portal, you can search the catalogue of available data, visualise it and download it.


Explore the Data


The below categories below relate to environmental variables which influence health and healthy ageing in our environment. These factors include, for example, light pollution, noise pollution, air pollution and soil pollution, as well as built infrastructure and availability of 'green space' and 'blue space'.



 Land Cover



 Climate



 Air and Emissions



 Noise and Light



 Geology

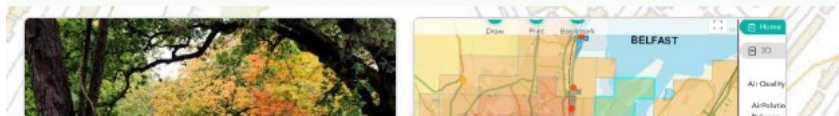

 Health


 Statistics


 Infrastructure


 Boundaries


 SPACE Outputs



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Filters Reset 1 - 12 of 69 Relevance Grid List

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Tag


Filter options


- Space (32)
- Osni (15)
- Air Pollution (8)
- Opendata (8)
- Geology (7)


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Category


- Road Infrastructure - Space (11)
- Pollution - Space (7)



Dataset
[Admin Boundaries](#)
Gemma.McNickle_QueensUB
OSNI Administrative boundaries


Dataset
[Health Socialcare](#)
Centre for Geographical Information and Geomatics ...
Health social care data gathered by OSNI for use in EPG


Dataset
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Centre for Geographical Information and Geomatics ...
Air Pollution - Particulate Matter 10 - DEFRA


Dataset
[Regional CO2 Emissions by Year](#)


Dataset
[Light at Night](#)


Dataset
[NI Traffic Count Data](#)

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Video series

5 themes:

1. Air & Soil pollution
2. Light & Noise pollution
3. Green & Blue space
4. Urban planning
5. Planetary health & Climate change

<https://www.qub.ac.uk/sites/space/VideoandFactsheets/>



Green and blue space	Noise pollution	Light pollution	Soil pollution	Air pollution	Urban planning	Planetary health and climate change
<p>Green space is any natural space that contains trees, grass or any other green vegetation. Blue space is any natural space that contains water, like rivers, lakes, and the sea.</p> <p>Exposure to green and blue space is linked to better health and well-being.</p> <p>1 in 5 people in Europe are exposed to high noise levels considered harmful to their health</p> <p>Over 80% of the world's population is living under light-polluted night skies</p> <p>Soil pollutants play a role in the environment and can impact we live and age. Inputs from potentially toxic elements in can impact cognitive health such as mercury and lead</p> <p>Air pollution is the biggest environmental health crisis</p> <p>99% of global population breathes that contains high levels of pollutants and is estimated to cause 6.7 million premature deaths each year</p> <p>Urban design has been historically health. Cities with a compact and complete mix of services available in shorter distances, walking and cycling can have lower levels of air pollution and better health outcomes cardiovascular disease</p> <p>Human health depends on flourishing natural systems. By harming our natural systems, we harm ourselves and future generations.</p> <p>Climate change is a context that creates unprecedented situations.</p>	<p>We asked members of our Healthy Ageing Advisory Group what they thought...</p> <p>"When you're out there walking, you feel a sense of freedom"</p> <p>"Outdoors is free, that's the best part of it"</p> <p>"People in cities don't notice the noise anymore"</p> <p>"Places are so built up and noise reflects from building to building, you don't have peace or quiet"</p>	<p>We asked members of our Healthy Ageing Advisory Group what they thought...</p> <p>"Recently, I haven't been able to see as many stars"</p> <p>"I always sleep better when I'm somewhere that doesn't have light pollution"</p>	<p>We asked members of our Healthy Ageing Advisory Group what they thought...</p> <p>"I notice if there's something different with smells in the air or if the soil is contaminated, especially living above a road or near the coast you can see the dirt coming in"</p>	<p>We asked members of our Healthy Ageing Advisory Group what they thought...</p> <p>"Where traffic does build up, you feel the fumes from the cars affecting you, particularly when walking along a country road"</p>	<p>We asked members of our Healthy Ageing Advisory Group what they thought...</p> <p>"Sometimes we don't think about it, we all hop in our cars and go"</p> <p>"Traffic has gotten a lot more noticeable, even in the outskirts"</p>	<p>We asked members of our Healthy Ageing Advisory Group what they thought...</p> <p>"I did notice this year has been warmer, and it can be a bit uncomfortable at times"</p> <p>"We should think about it - what are we doing to our lovely planet?"</p> <p>Bringing together a range of bodies in partnership from across the public, private and third sector to raise awareness, guide good policymaking, and create actions is crucial.</p>
<p>A better understanding of health and urban green spaces can make better evidence-based decisions</p>		<p>A better understanding of our health and well-being can lead to better solutions, and evidence</p>		<p>Understanding how all planetary, environmental and health factors interact can help inform planners and citizens of the many components affecting how we live and age</p>		<p>The health of citizens and the planet is central to create conditions where everyone can live and age well</p>
<p>SPACE logo and QR codes for each fact sheet.</p>						

This work was supported by UK Research and Innovation [ES/V016075/1]



Workshops

An Introduction to Directed Acyclic Graphs (DAGs) for Causal Inference - Online Training

Workshop 1 - Wednesday 11 May 2023

In the video below:

- a short introduction to causality
- you will learn the essentials of DAGs
- you will learn what a confounder, a mediator, and a collider are
- you will learn the d-separation rules
- the session ends with a DAGitty demonstration that you can replicate at home to create your own DAGs

- [Training Video](#)
- [Dagitty Codes](#)
- [Dagitty Guide](#)
- [Workshop Presentation](#)

<https://www.qub.ac.uk/sites/space/Resources/#an-introduction-to-directed-acyclic-graphs-dags-for-causal-inference-online-training-1844834-1>

Introduction to Directed Acyclic Graphs (DAGs) for Causal Inference

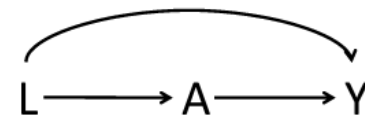
Session 1

Ione Avila-Palencia, PhD, MPH
Hüseyin Küçükali, MD, PhD
11th May 2023

Introduction to causality	DAGs: the essentials	Confounder, mediator, collider	SPACE example	d-separation rules	Work with examples	DAGitty demonstration
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What is a DAG?

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- DAG: Directed Acyclic Graph
- Mathematical object built from letters and arrows
- Visual representation of qualitative causal assumptions



Summary

- Causal loop diagram
- Evidence Gap Map
- Evidence on environment and cognitive health
- Methodological innovations / training workshops
- Linked environment and health dataset – international comparative studies
- Geoportal
- White paper – policy agenda setting
- Practice-oriented outputs
- Videos and factsheets

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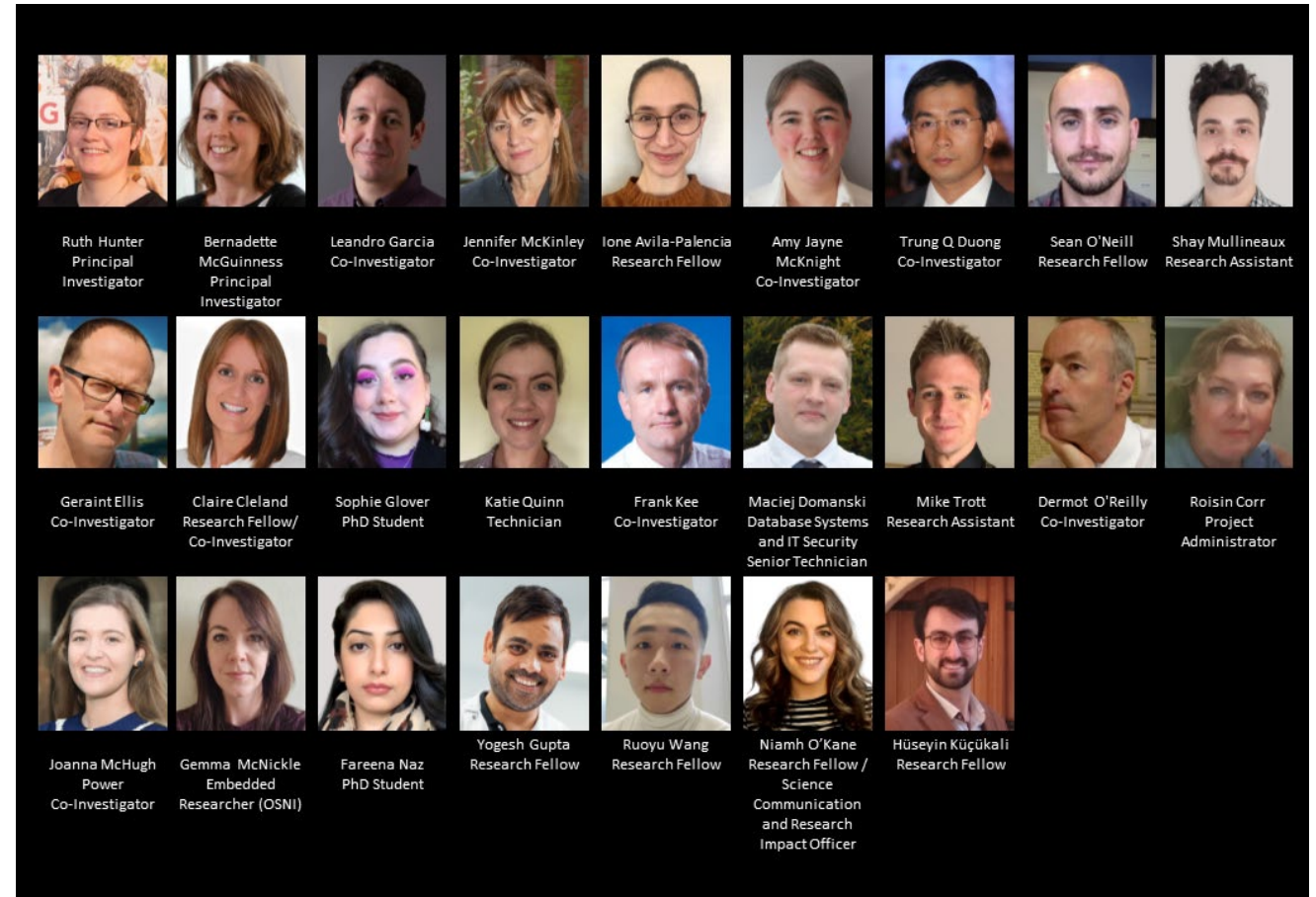
Professor Ruth Hunter
 Professor of Public Health and
 Planetary Health
 Centre for Public Health
 Queen's University Belfast
 E-mail: ruth.hunter@qub.ac.uk

Twitter: [Ruth_HunterQUB](https://twitter.com/Ruth_HunterQUB)



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The SPACE Team



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