SPACE: the impact of place on cognitive health

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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]

Economic and Social Research Council

Healthy Ageing Challenge Social, Behavioural and Design Research

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

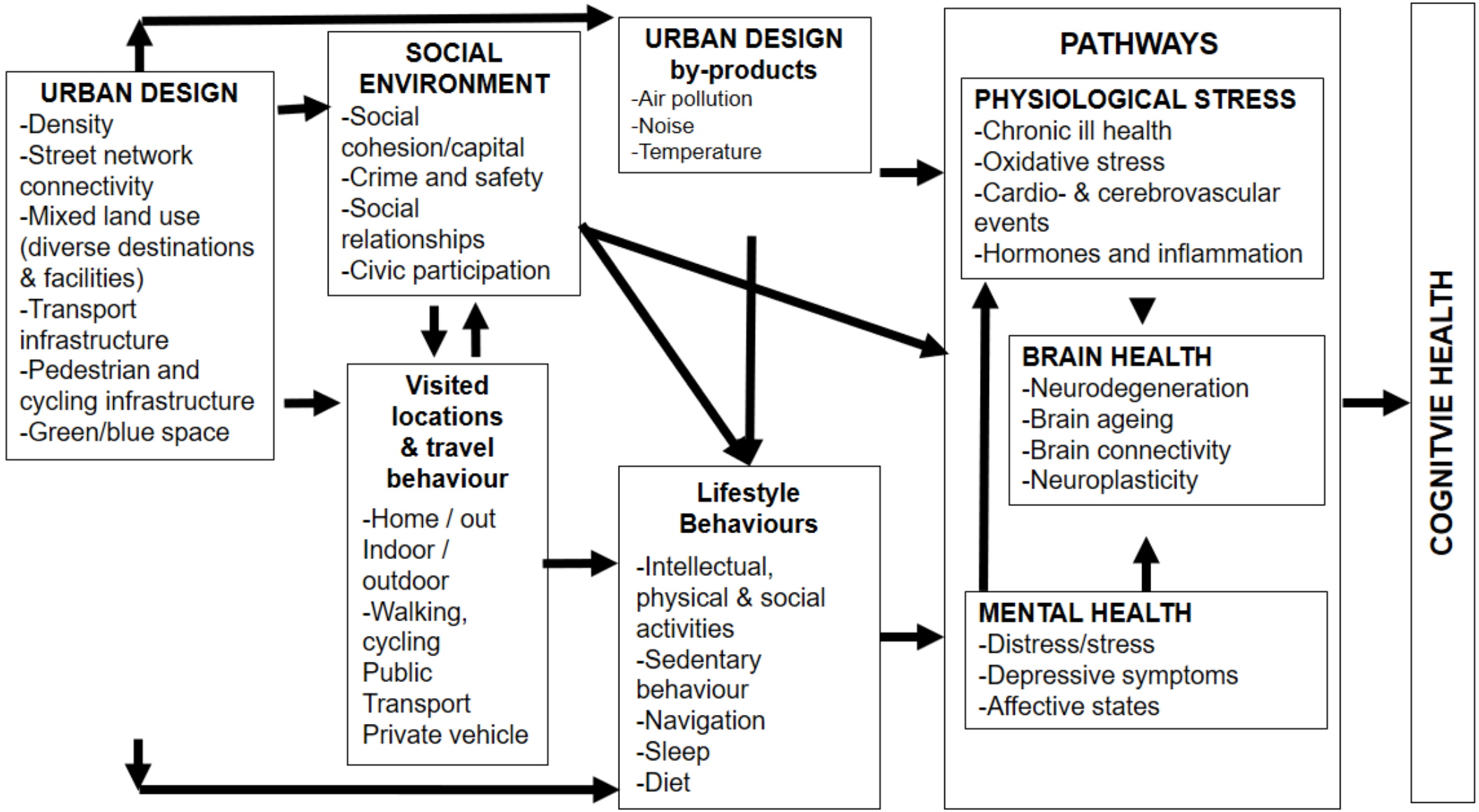


Figure 1: Conceptual model of the effects of urban environment on cognitive health (Adapted from Cerin et al, 2020)

SPACE

OVERVIEW

1.Systems science approach

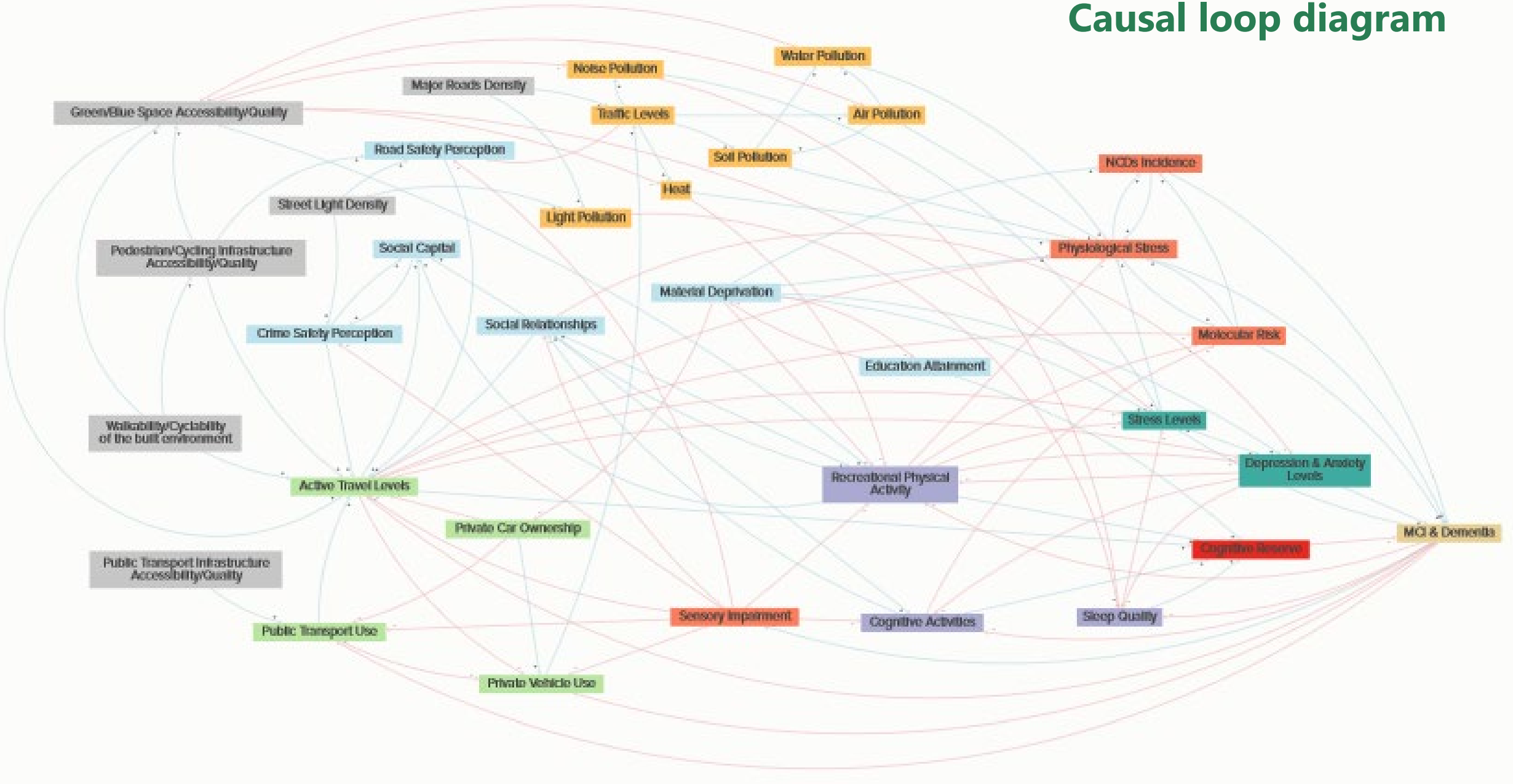
2. Spatial environmental data linkage

3. GPS and accelerometry data

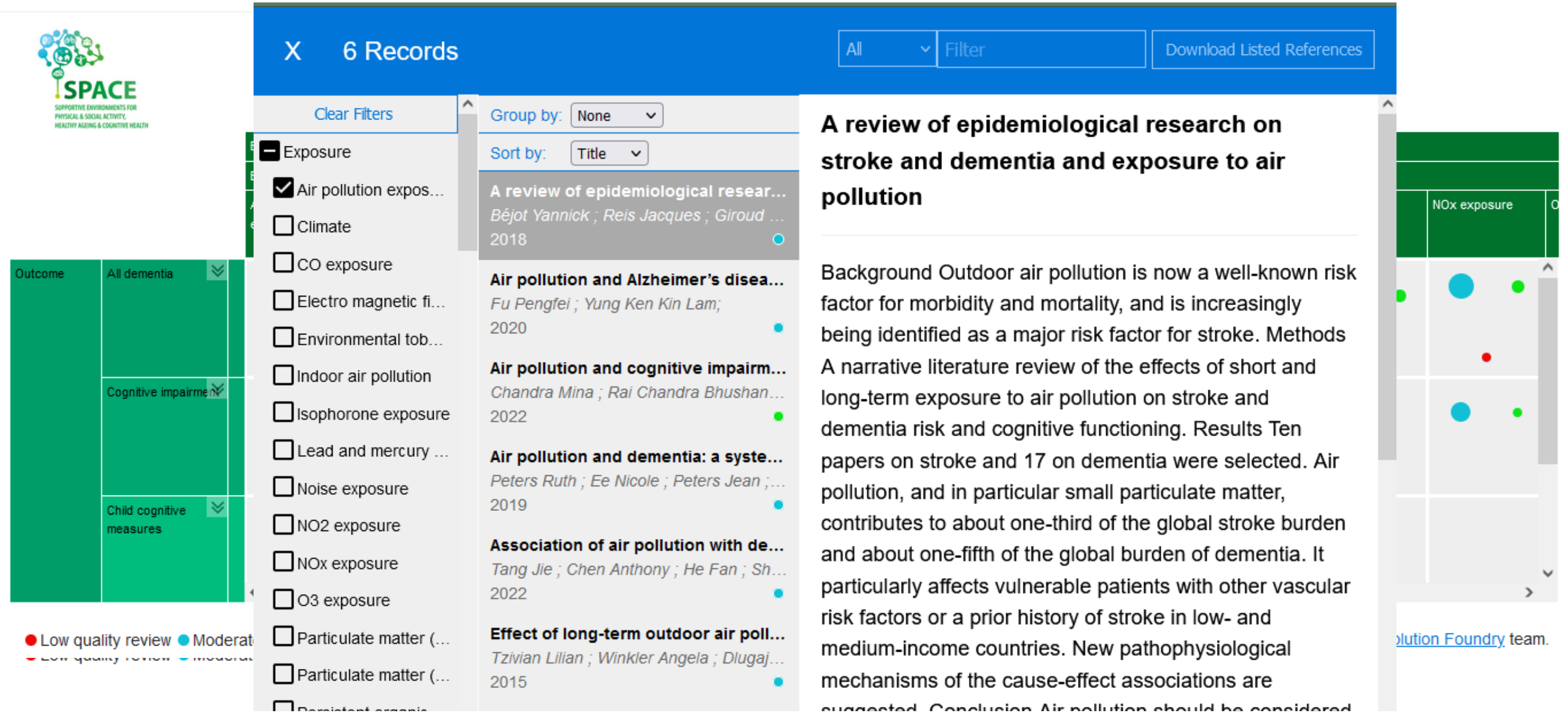
4. Biological responses using multi-omic approaches

5. Satellite imagery for creating harmonisable environment data

Causal loop diagram



Interactive Evidence Gap Map



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 (NO2 and PM2.5), noise and light pollution
Soil geochemistry	Urban geochemical data including soil urbanisation tracers (Co, V, Cr, Ni, Zn, Sn, Pb, Sb, As and Mo)**

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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?

Cognitive decline	Cognitive health
Social isolation	Access to greenspace
Exposure to toxic elements	Educational attainment

Decreased risk of disease

Increased longevity

Maintenance of biological processes

DNA methylation

Histone modification

Changes in chromatin structure

Increased risk of disease

Disease progression

Age acceleration

Biomarker of risk or disease

Biological changes in response to environmental stimuli

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

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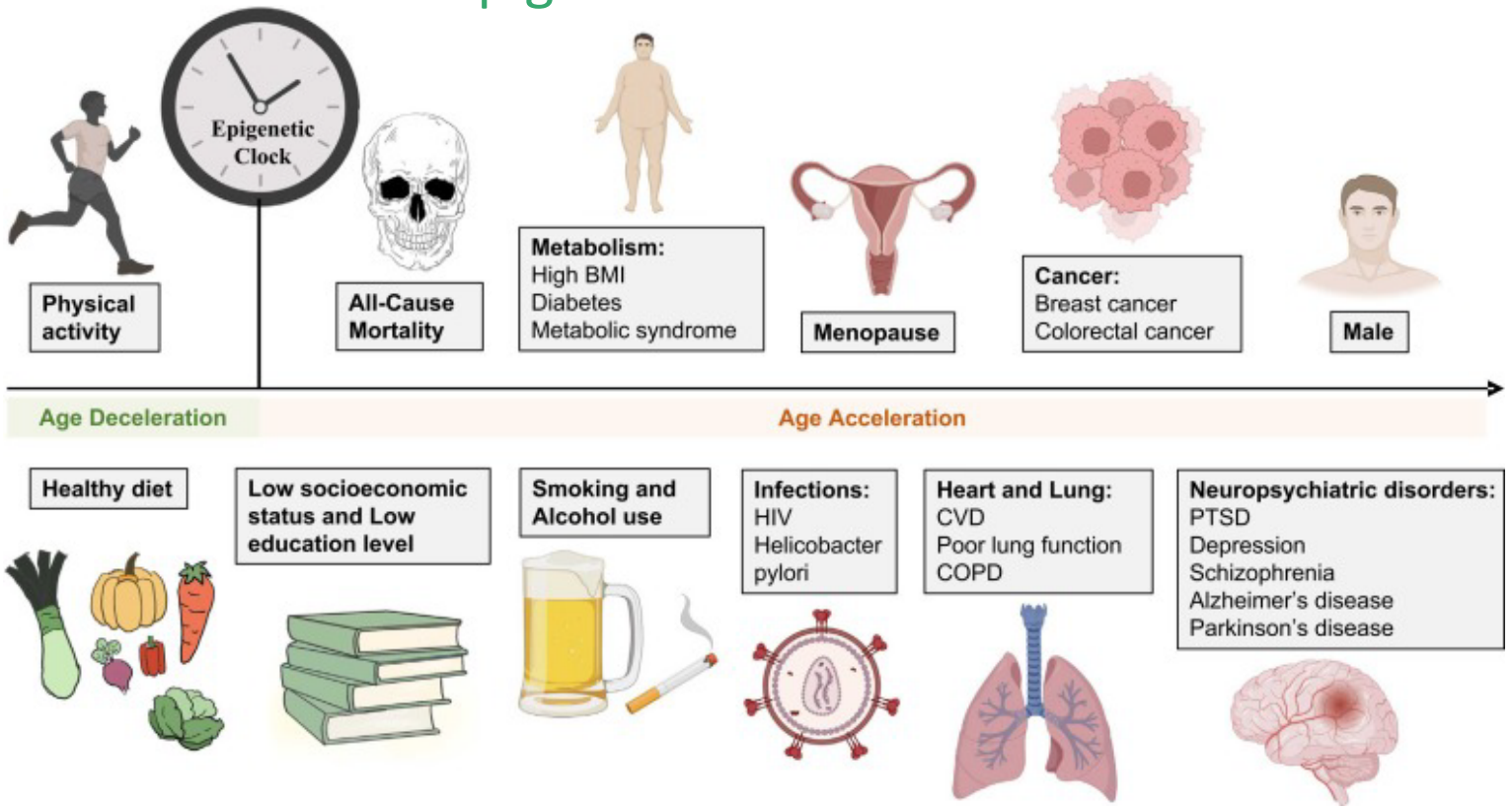
Eleven epigenetic clocks are now generated for NICOLA, both PCA adjusted and the original clocks -> being run for environmental phenotypes & health related outcomes.

Epigenetic Clock



PMID: 36206857

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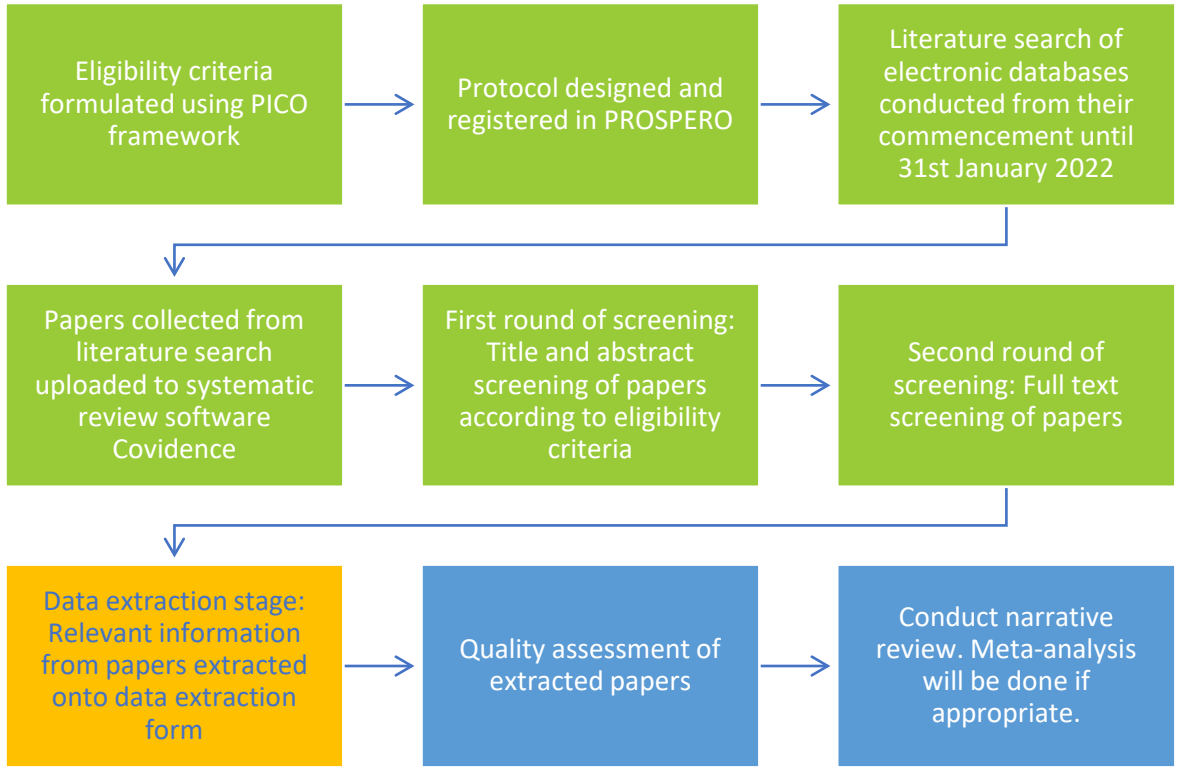
Systematic review: Environmental exposure and associate genetic/epigenetic changes with adverse health effect

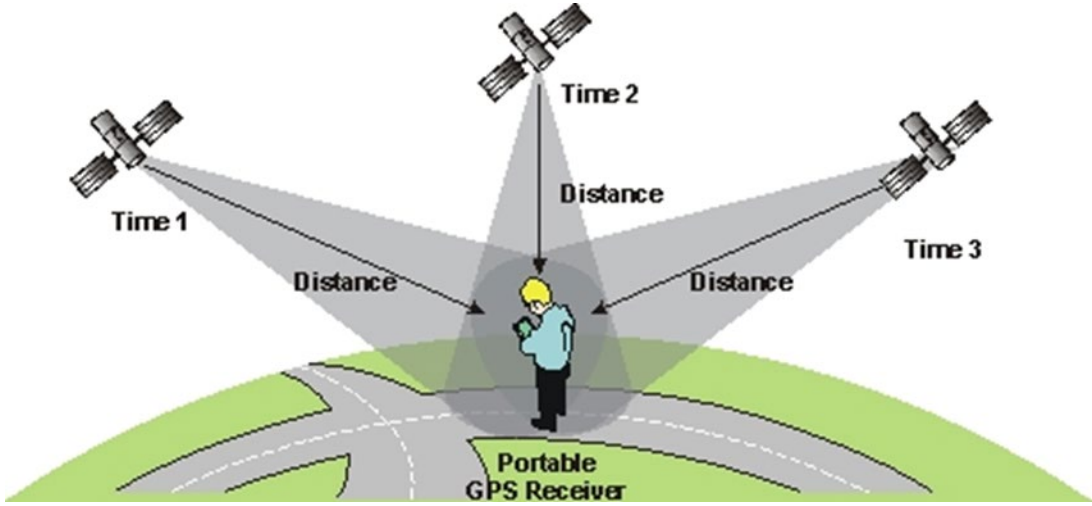


63,810 papers identified from the literature search of electronic papers,

2,845 papers passed title and abstract screening,

794 papers are in data extraction.

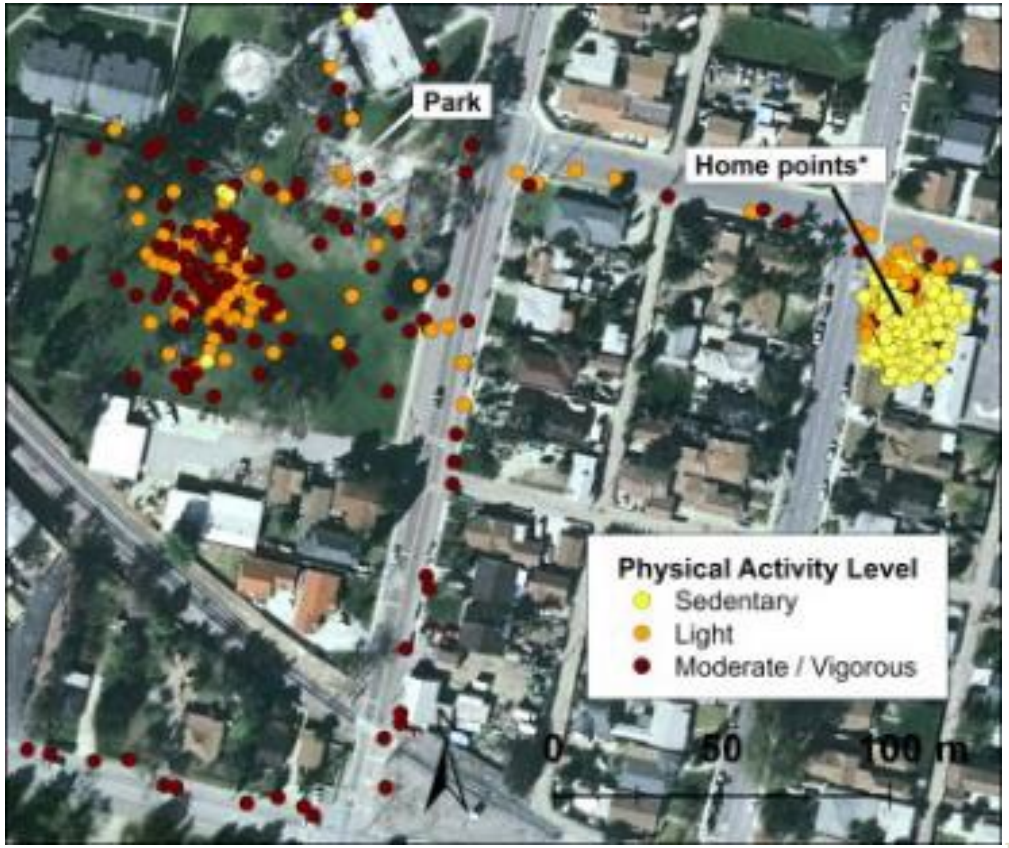
GPS and accelerometer data



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]



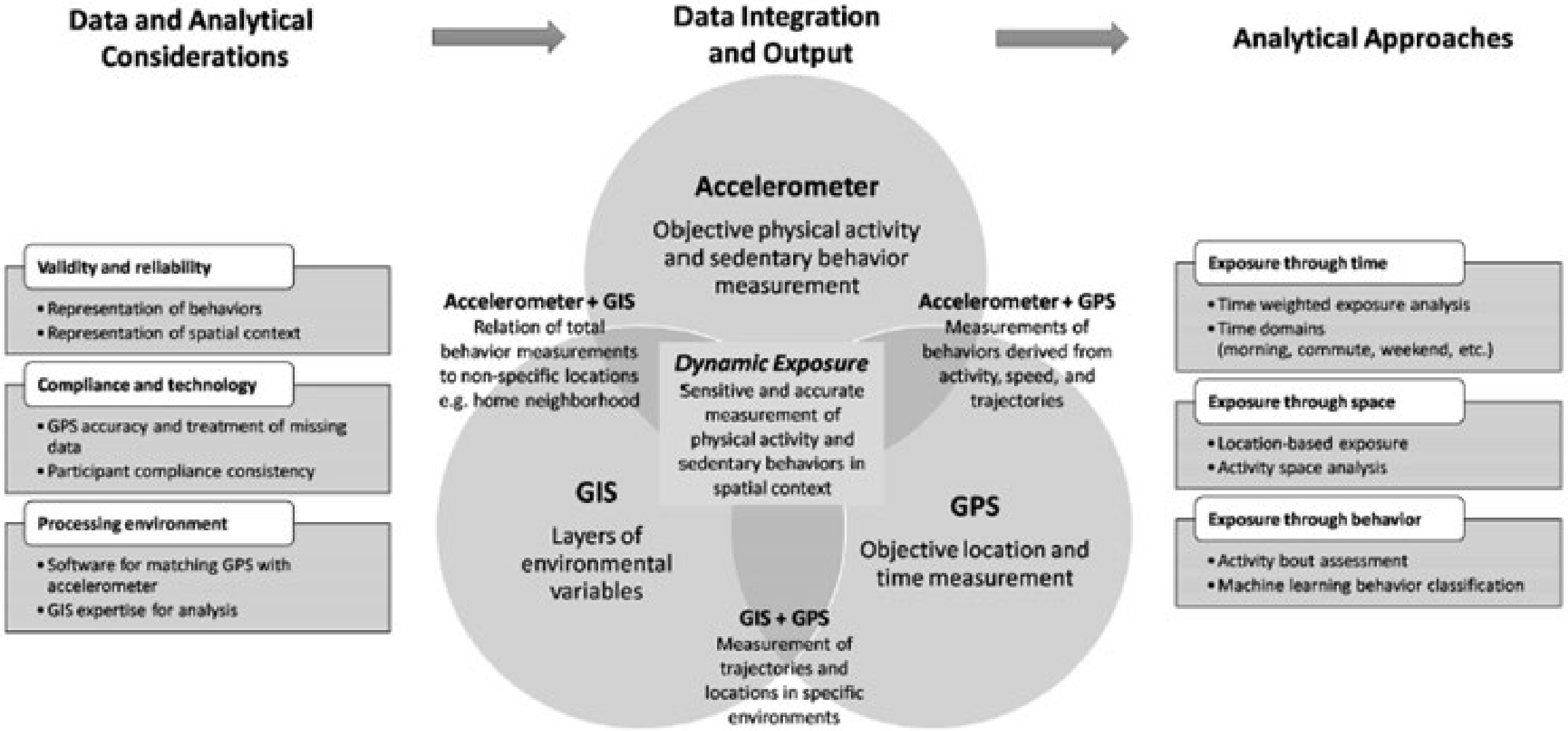


Figure 2.
Framework for integration of GPS, accelerometer, and GIS technology.

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

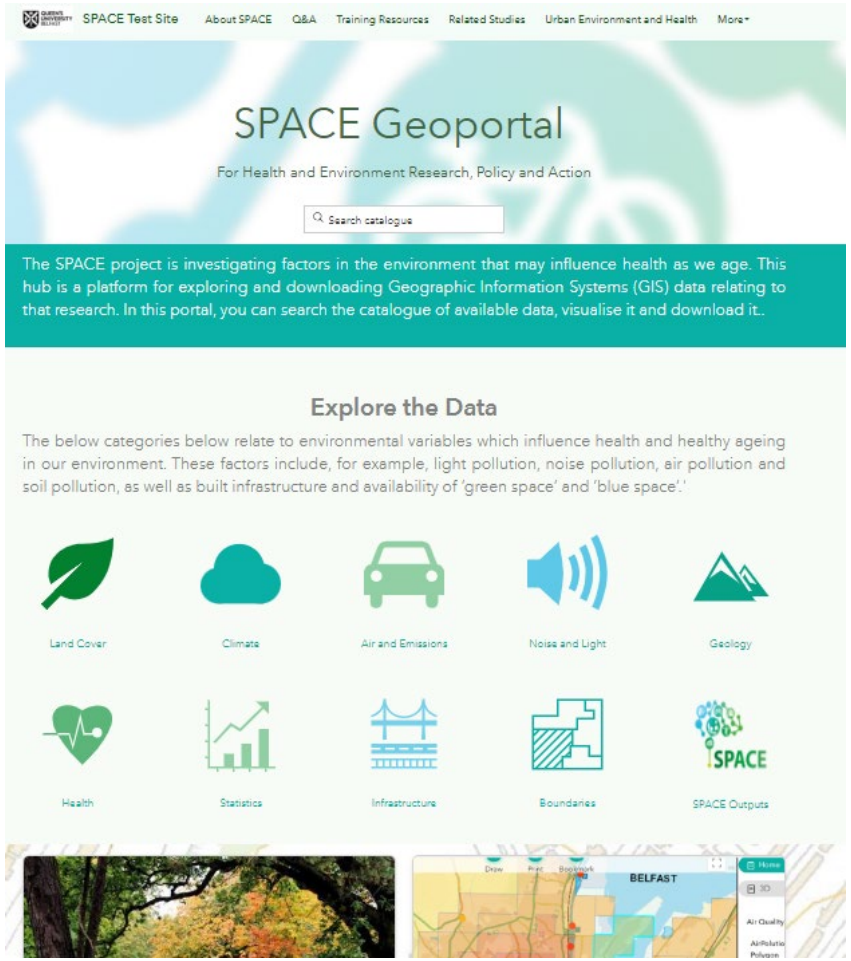
- Cognitive health lacking on the policy agenda
- Addressing the root causes of poor-quality environments will have benefits across a range of policy areas

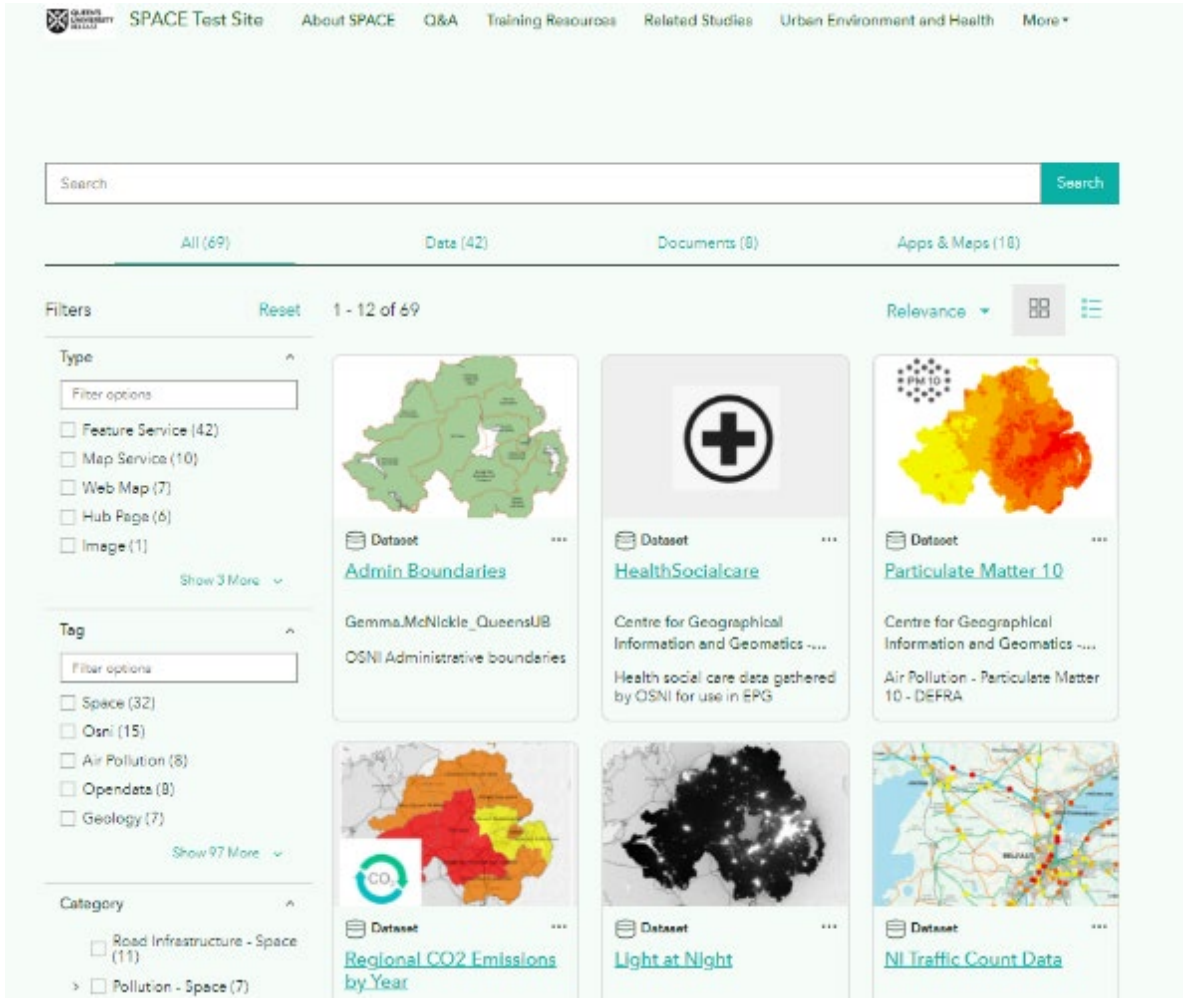
Addressing:
Poor transport infrastructure, absence of good-quality green space, poor housing

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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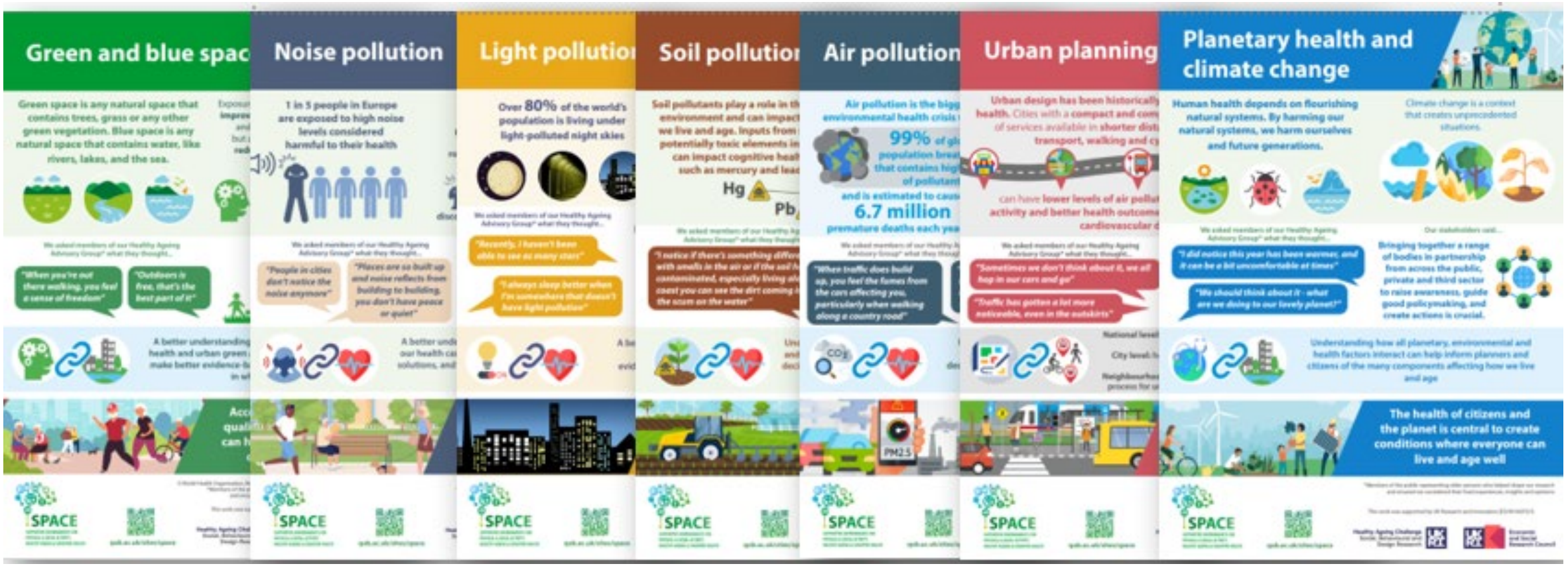
Video series

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/VideosandFactsheets/

Fact Sheets



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Workshops

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

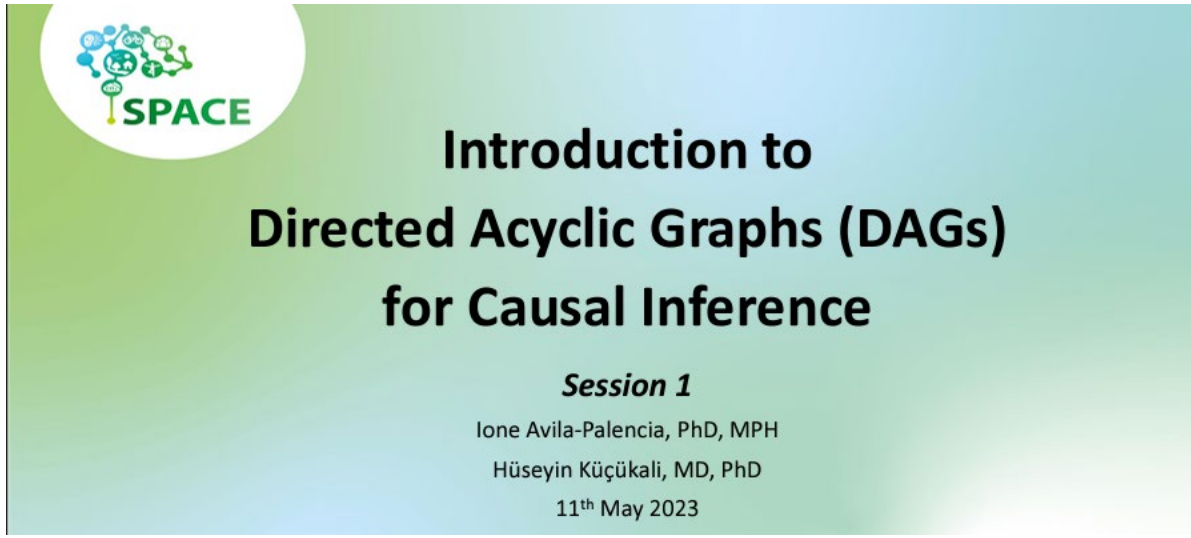
Workshop 1 - *Wednesday 11 May 2023*

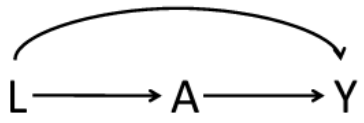
In the video below:

- 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





- 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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