



HD4 | Health-Driven Design for Cities

Reimagining our urban futures

People living in cities face growing challenges to their health and wellbeing: heat, noise, air pollution and limited opportunities to eat healthily and be physically active.

HD4 will investigate how individuals live and move in Singapore, how the urban environment shapes their exposure to health risks and how this influences their behaviour and health.

Funded by the National Research Foundation, Prime Minister's Office, Singapore under its CREATE programme, HD4 brings together a team of epidemiologists, clinicians, scientists, engineers and architects from Nanyang Technological University, National University of Singapore and the University of Cambridge.

The programme is integrating environmental data with health and behaviour data in the SG100K cohort study, helping us understand how we might change the fabric and organisation of cities to make them healthier for all of us.

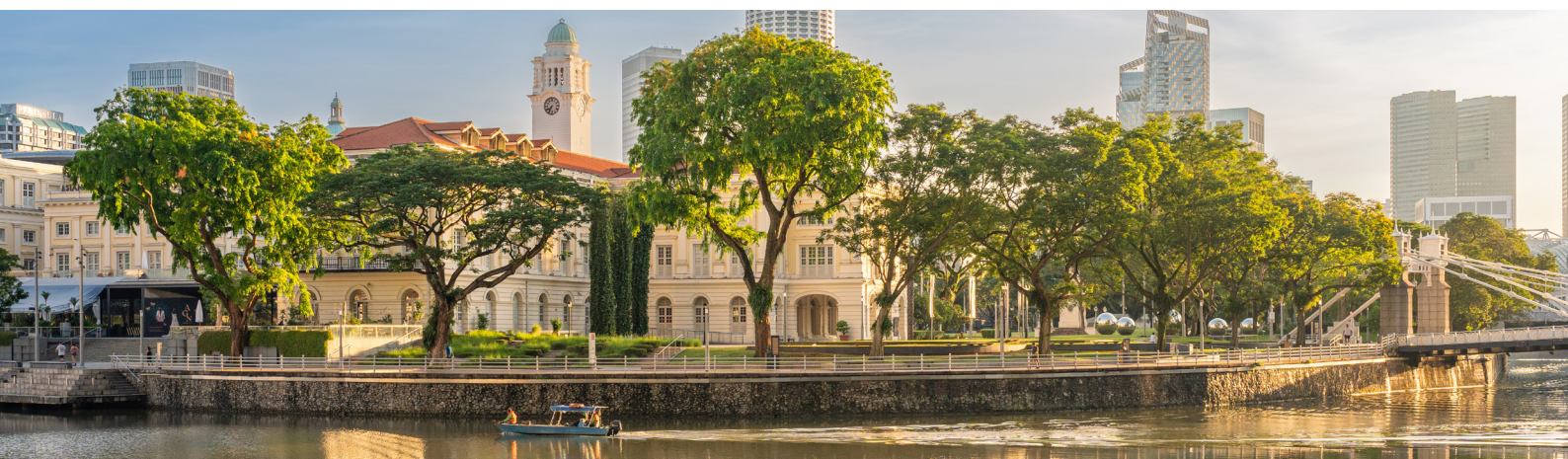
As a city with ambitious health goals, rich data and the drive to turn research into real change, Singapore offers a unique setting. HD4 will work in partnership with government agencies, so that the science can guide Singapore's planning and health strategies in the years ahead.

HD4 research objectives

HD4 will undertake research in the following areas:

- Characterising features of the Singapore environment that potentially impact health
- Understanding the links between environmental factors, individual behaviour and health outcomes
- Observing the impact of environmental change on health in Singapore
- Working with government agencies to explore the development of useful public health tools

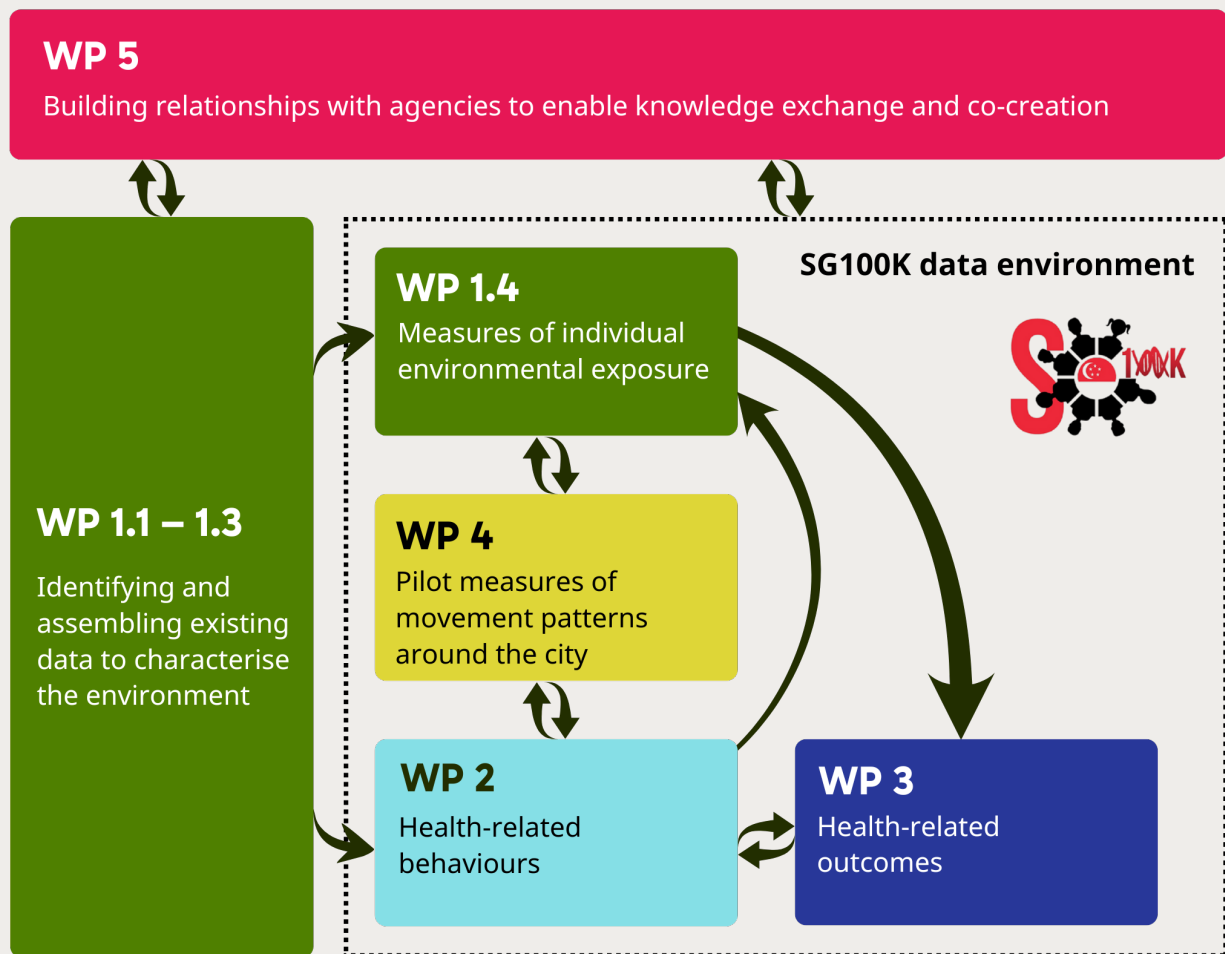
HD4 Programme Leads: Nick Wareham (Cambridge), John Chambers (NTU)



HD4 is supported by the National Research Foundation, Prime Minister's Office, Singapore under its Campus for Research Excellence and Technological Enterprise (CREATE) programme.

HD4 Phase 1 Research Plan

HD4 will proceed in two phases. Phase 1's five interconnected work packages will show how we can link data describing individual environmental exposures to the wealth of health data in SG100K. This will pave the way for Phase 2, which will identify interventions to help improve the health of Singaporeans.



WP1: Urban environmental exposures for SG100K participants

Leads: Ronita Bardhan (Cambridge), Rudi Stouffs (NUS), Liya Yu (NUS)

The places where we live and work influence our health over time. To understand these potential impacts, HD4 is gathering data on Singapore's urban environment from government agencies and open-source platforms. This includes information such as weather indicators, features of the built environment, population density and other socio-demographic markers.

Data will be used to measure how urban factors including heat stress, air pollution and access to transport affect people in different areas. Researchers will group areas with similar characteristics and classify the types of environments in which people live.

Researchers will then link this information to the anonymised residential data of SG100K participants, to gain a greater understanding of individual exposures.

The data assembled by WP1 will support the discovery of links between environmental factors, behaviours and health outcomes in WP2 and WP3.

Research objectives:

- Identify data sources to characterise environmental exposures
- Generate location-based urban exposure measures of humid heat stress, air pollution, food retail accessibility, land use, amenities and infrastructure
- Develop geospatial and data-driven models to define urban exposures
- Link participants in SG100K to environmental exposures calculated using existing data and describe the variation in exposures by socio-demographic factors

WP2: Relationship between urban environments and health-related behaviours

Leads: Louise Foley (Cambridge), Marie Loh (NTU), Jenna Panter (Cambridge)

Cities are dynamic, evolving entities shaped by and for people. Understanding the links between urban built environments and the health-related behaviours of residents is crucial for addressing the challenges and opportunities of rapid urbanisation and creating more sustainable, healthy and equitable cities.

However, many questions in this area remain unanswered, particularly in a diverse, multi-ethnic population like Singapore. WP2 will draw on data captured in WP1 and link this with information from SG100K to allow us to explore environment-behaviour relationships.

Characteristics of the city to be explored include land use, walkability, transport infrastructure, green and blue spaces, food retail and noise.

We will link these with behaviours including physical activity, diet and sleep.

These findings will inform WP3, which will investigate the relationship between environments, behaviours and health outcomes. Our intention is to produce evidence that addresses agency needs and priorities.

Research objectives:

- Characterise the associations of environmental characteristics with physical activity, sedentary behaviour, sleep, diet and fitness
- Characterise health behaviours over time and by population subgroup

WP3: Relationship between environments, behaviours and health

Leads: Nita Forouhi (Cambridge), John Chambers (NTU), Sim Xueling (NUS)

WP3 will complement insights from WP1 and WP2 to examine the inter-relationships between the environment, health behaviours and health outcomes.

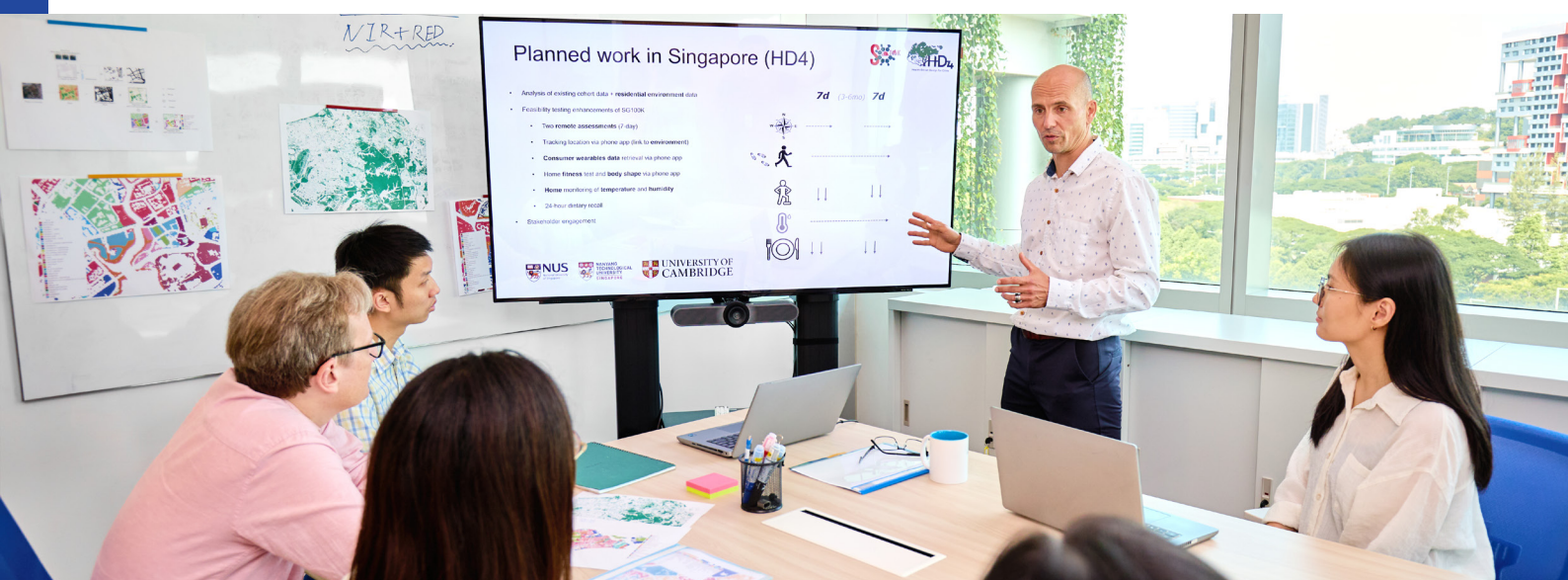
Using the anonymised long-term health records of thousands of people in SG100K, researchers will study the links between the environment and diseases such as type 2 diabetes, heart disease and stroke. By tracking changes in health markers over time – such as body fat, blood pressure and blood sugar – we can understand how the environment influences disease risk in Singapore's multi-ethnic population.

Previous studies have mostly looked at single influences on health, but people are usually exposed to many influences at once.

This research will examine how different environmental factors (for instance the food landscape, green space or air pollution) interact with behaviours (such as diet quality or physical activity) to affect health outcomes.

Research objectives:

- Examine the cross-sectional and prospective associations between environmental exposures and health outcomes
- Investigate the independent and joint associations between environmental exposures, health behaviours and health outcomes



WP4: Novel approaches for improving assessment of person-level environmental and behavioural exposures

Leads: Søren Brage (Cambridge), Falk Müller-Riemenschneider (NUS), Jason Kai Wei Lee (NUS)

No two individuals interact with the environment in the same way: their behaviours such as physical activity, sleep and diet will vary depending on where they are and when measurements are taken.

WP4 focuses on developing new, scalable ways to more accurately track health, behaviours and environmental exposures using digital tools.

The research aims to move beyond traditional static location measurements, such as home addresses, by testing methods to track how people move through their environments. By using smartphones and wearables, it will derive health status metrics that may be used to monitor

impacts of changes in behaviour.

Findings from these pilot studies will demonstrate the potential to employ such methods for future population health monitoring.

Research objectives:

- Pilot smartphone-based dynamic assessment of people's location and movement in the environment
- Pilot smartphone-based assessment of physical fitness and humid heat stress in the home environment
- Implement and test digital assessment of dietary intake

WP5: Making an impact through agency collaborations

Leads: Thomas Burgoine (Cambridge), Ng Yih Yng (NUS), Bernett Lee (NTU)

HD4 will generate evidence that is directly relevant to Singapore and other urban settings in Asia. But this evidence can only create change by being shared and used. WP5 will work closely with key stakeholders in government agencies to share knowledge and co-create research that has real-world impact.

Central to this effort are the Stakeholder Advisory and Stakeholder Expert Groups, which will promote open, two-way communication through regular meetings. This continuous dialogue will foster a shared understanding of Singapore's public health challenges, which will pave the way to jointly develop new data tools to support policy and practice.

WP5 will also use traditional, social and digital media to communicate HD4's work to the wider public, through avenues such as newsletters, workshops and a dedicated website.

Research objectives:

- Organise stakeholder engagement, including the convening of stakeholder groups
- Disseminate HD4 findings using traditional, social and other digital media
- Support the early development of online decision-support tools

Find out more: www.cares.cam.ac.uk/research/hd4-project

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