The Australian Prevention Partnership Centre

Benchmarking, monitoring, modelling and valuing the healthy liveable city

Final report

July 2022

Benchmarking, monitoring, modelling and valuing the healthy liveable city: Final report

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Indicator data and maps can be accessed through the Australian Urban Observatory: auo.org.au

Our funding partners

The Australian Prevention Partnership Centre is funded by the NHMRC, Australian Government Department of Health, ACT Health, Cancer Council Australia, NSW Ministry of Health, Wellbeing SA, Tasmanian Department of Health, and VicHealth. The Prevention Centre is administered by the Sax Institute.

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Abbreviations

ASGS	Australian Statistical Geography Standard
AToM	Agent- and activity-based Transport model for Melbourne
CAUL	Clean Air and Urban Landscapes Hub
CRE-HLC	Centre for Research Excellence in Healthy, Liveable Communities (funded by the NHMRC)
JIBE	Joining Impact models of transport to the Built Environment project
NHMRC	National Health and Medical Research Council
PIA	Planning Institute of Australia
SRL	Suburban Rail Loop (being built in Melbourne)
UKRI	United Kingdom Research Institute
VISTA	Victorian Integrated Survey of Travel and Activity

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Funder and funding partners for this project

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The co-funding of the liveability work through the NHMRC Centre of Research Excellence in Healthy Liveable Communities (#1061404) and Clean Air and Urban Landscape Hub, funded by the National Environmental Science Program, is also gratefully acknowledged.

The Australian Prevention Partnership Centre (the Prevention Centre)

The Prevention Centre is a national initiative aimed at preventing chronic and lifestyle-related diseases, by undertaking prevention-related research in collaboration with a network of more than 150 leading academics, policy makers and practitioners. Initial resourcing was provided by the NHMRC, NSW Health, ACT Health, the Australian Government Department of Health and the HCF Research Foundation. The Prevention Centre includes almost 30 agencies, with research administration through the Sax Institute, led by Director Professor Andrew Wilson and Professor Lucie Rychetnik.

The Prevention Centre takes a systems-based approach to tackling the chronic disease epidemic that is affecting more than 80% of Australians.

More information can be found on the Prevention Centre website: www.preventioncentre.org.au.

NHMRC Centre of Research Excellence in Healthy, Liveable Communities (CRE-HLC)

The CRE-HLC was funded from 2014 to 2020. It investigated cost-effective interventions in the built environment, to create healthy, liveable and equitable communities in Australia. It was structured around five themes:

- To advance the measurement of built-environment attributes aligned with health and urban policy
- To determine causal relationships and mechanisms between the built environment, and health and wellbeing
- To determine thresholds for built-environment interventions to maximise health and wellbeing
- To conduct economic evaluation of built-environment interventions for healthy, liveable and equitable communities
- To translate and disseminate the research findings from the previous four themes into positive changes to urban planning policy and practice.

The research from the CRE-HLC formed the conceptual foundation of the liveability research undertaken in this project, and of the liveability indicators for Australia's 21 largest cities – as described in this report and disseminated through the Australian Urban Observatory.

Clean Air and Urban Landscapes Hub (the CAUL Hub)

The CAUL Hub was funded by the Department of Environment's National Environmental Science Program. It funded the Healthy Liveable Cities Lab's research from 2015 to 2018. CAUL funding enabled us to develop policy-relevant indicators and explore the relevance of liveability indicators for regional cities in Victoria. This research confirmed that the liveability indicators we identified for capital cities were also relevant to regional cities. This paved the way for the development of liveability indicators for Australia's 21 largest cities.

RMIT University

Many members of the Healthy Liveable Cities Lab team working on Prevention Centre projects were partly supported by the Urban Futures Enabling Capability Platform (2017–20) and funding through Distinguished Professor Billie Giles-Corti's Vice-Chancellor's Professorial Fellowship (2021–25). The team joined RMIT University in the Centre for Urban Research in 2017. The Centre for Urban Research is an international leader in urban and interdisciplinary research, including urban planning, public policy, geography, economics, environmental sciences, spatial analysis, history and sociology. RMIT University is known for its applied, policy-relevant and collaborative work with government and industry in undertaking innovative research.

Research partners for this project

Our research partners for this project have included the Australian Government Department of Health and Aged Care, South Australia Health and VicHealth. All partners have a strategic interest in learning about relationships between the built environment and health.

Australian Government Department of Health and Aged Care

The role of the Australian Government Department of Health and Aged Care is to develop and deliver policies and advise the Australian Government on health, aged care and sport, to ensure better health for all Australians.

Representative:

Marijke Adderley
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Australian Government Department of Health

South Australia Health (SA Health)

SA Health provides leadership in health reform, public health services, health and medical research, policy development and planning for protecting and improving the health of all South Australians. It focuses in particular on wellbeing, illness prevention, early intervention and quality care.

Representative:

Professor Katina D'Onise
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The Victorian Health Promotion Foundation (VicHealth)

VicHealth focuses on health promotion and preventing chronic disease by creating interventions, research and campaigns that promote health for all Victorians. Its focus areas include promoting healthy eating, encouraging regular physical activity, preventing tobacco use, preventing harm from alcohol, and improving mental health.

Representative:

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Introduction

Interest in creating liveable and sustainable cities has grown locally, nationally and globally over the last decade. Defined in public health terms, liveable cities are "safe, socially cohesive and inclusive and environmentally sustainable, with affordable housing linked by convenient public transport and walking and cycling infrastructure to employment, education, health and community services and leisure and cultural opportunities".[1,2] Liveable cities therefore have the potential to improve population health, strengthen the economy, increase social inclusion and environmental and social sustainability, and reduce inequities.

In the last two decades, a mounting body of evidence has demonstrated the public health benefits of creating healthy liveable cities that provide access to local destinations within a walkable catchment.[3,4] In Australia, through a 10-year research program, the team at the Healthy Liveable Cities Lab has studied associations between seven underlying domains of urban liveability (access to employment, healthy food, affordable housing, public open space, social infrastructure, public transport, and walkability) and health and wellbeing.[5-20] Sub-domains of liveability associated with health and wellbeing were incorporated into an Urban Liveability Index, which has been shown to be significantly and positively associated with walking, cycling, public transport use[21] and a more physically active lifestyle.[22] Conversely, the Urban Liveability Index was negatively associated with private motor vehicle use[21], and with several risk factors for cardiometabolic disease including body mass index. Living in neighbourhoods with diverse community, culture and leisure destinations – a marker for a more established and vibrant neighbourhood – was negatively associated with being diagnosed with hypertension or type 2 diabetes.[22]

This report describes the results of the project 'Benchmarking, Monitoring, Modelling and Valuing the Healthy Liveable City', which is the third project in the National Liveability Study series funded by The Australian Prevention Partnership Centre (hereafter referred to as 'the Prevention Centre'). It sought to go beyond '**why'** we should make the transition to healthy liveable cities, and '**which'** interventions were likely to support this transition, to '**how**' to design policy and interventions to create healthy liveable cities. This project extended our team's previous liveability work, by creating a national database of evidence-based liveability indicators visualised and disseminated through the Australian Urban Observatory (https://auo.org.au/), and by creating a 'virtual laboratory' that could be used to identify and test urban and transport planning and design interventions. Before describing the current project and its results, we provide context by briefly describing the background that led to the current project.

Background

In 2013, the Prevention Centre funded the first National Liveability Study, to develop and validate a set of national, urban, policy-relevant indicators of spatial liveability associated with non-communicable disease risk behaviours and/or outcomes. Working with a national team of public health and geospatial scientists, we sought input from an advisory group and other stakeholders to identify a set of liveability indicators – access to alcohol, healthy food, public open space, transport, walkability – which we then developed and validated against measures of health and wellbeing in Australian capital cities.[6, 9, 10, 18, 23] This built on conceptual and validation research undertaken in Melbourne as part of the NHMRC Centre of Research Excellence in Healthy Liveable Communities (CRE-HLC)[5-20], in preparation for calculating and mapping liveability indicators for all major Australian cities.

The second National Liveability Study involved consultations with external parties (for example, data providers, other indicator developers, spatial data portals, researchers) on ways to access and use liveability indicators.[24] Through these consultations, and the project's final workshop, we identified preferred options for developing and disseminating the liveability indicators. Methodological studies were also undertaken to make sure the liveability indicators would be robust, and the scale at which they should be measured was appropriate.[13, 14]

A proof-of-concept study, conducted in four capital cities around Australia, demonstrated the value of liveability indicators for benchmarking and monitoring policy. To this end, in partnership with the CRE-HLC and the CAUL Hub, the Creating Liveable Cities study was undertaken.[25] The study aims were to:

1. Review liveability-related state government policies in Perth, Brisbane, Sydney and Melbourne
2. Create national indicators to assess policy implementation in those cities
3. Map and examine spatial distribution of health-related policy-relevant spatial indicators
4. Make recommendations for creating liveable cities, recognising variations within and between Australian cities.

The report found that all four cities appeared to value the concepts of 'walkability' and 'liveability'. However, the policy review revealed little consistency in the policy requirements to achieve walkable and liveable cities across the country. No measurable spatial policy standards were identified for local employment, housing affordability, promoting access to healthy food choices, or limiting access to alcohol outlets. Where measurable standards were available, they were often insufficient to achieve the desired result. Indeed, there was little consistency in understanding how to create healthy liveable cities. Policies varied markedly in the specific urban characteristics sought and measured, and in their levels of policy ambition. Built environments that support health were distributed inequitably across the city, with people living in outer suburbs generally poorly served. The report recommended using spatial liveability indicators to benchmark and monitor the implementation of policy over time. This recommendation was adopted by the Victorian Government in its report on 20-minute neighbourhoods.[26]

Benchmarking, monitoring, modelling and valuing the healthy liveable city

The report *Creating Liveable Cities in Australia*[25] revealed a considerable gap between the rhetoric of liveability and its implementation in urban policies and in actual communities. Liveable cities that offer residents a full range of infrastructure and amenities for daily living require integrated planning across many sectors and between different levels of government.[3]

Although there is substantial evidence on *why* we should make the transition to healthy liveable cities, and *which* urban planning and transport interventions are needed,[4,27] there is insufficient evidence on *how* interventions could and should be implemented to make this transition, and the likely consequences of those interventions. In addition, serious gaps in research prevented the translation of research into policy. Such gaps included the need for studies using complex-systems models designed in consultation with urban planning experts and tested using advanced statistical methods. This final Prevention Centre project in the National Liveability Study series aimed to close these gaps.

Project overview

Building on the earlier National Liveability Studies supported by the Prevention Centre[24], and on other related work funded by the NHMRC CRE-HLC and the CAUL Hub, this final project aimed to inform policy and practice by providing both data and research-validated tools that would improve understanding of the relationship between built environments, daily activities and travel choices. This project aimed to:

- Develop a national platform of urban liveability indicators temporally, spatially, and demographically, to benchmark and monitor the health and wellbeing of cities

  Assess the potential for achieving the '30-minute city' (where employment is accessible within a 30-minute walk or public transport trip for most residents) by different modes of transport
- Use these indicators in conjunction with other data in a simulation model for selected capital and regional cities in Australia
- Assess the merits of specific interventions designed to create healthy, liveable communities, including a health impact assessment.

These aims were achieved through a variety of sub-projects, which we introduce here and detail in the sections that follow.

We presented the new project to our new partners in a Welcome Webinar in 2019. They were introduced to the Healthy Liveable Cities Lab research team and our previous research on liveability, and we sought their feedback on the research proposed for this project.

The sections that follow describe the sub-projects and studies undertaken as part of this project. However, in summary, through this project we have:

- Established the Australian Urban Observatory, which disseminates liveability indicators for Australia's 21 cities (auo.org.au)
- Developed a series of liveability scorecards with up-to-date data on the liveability of Australia's 21 largest cities, which have been visualised and disseminated through the Australian Urban Observatory website (auo.org.au/measure/scorecards)
- Published our methodology for developing the liveability indicators, and created a GitHub repository to make these data available to other researchers
- Analysed the liveability of Australia's 21 largest cities, and examined spatial and socioeconomic inequities in access
- Analysed access to employment within 30 minutes by active transport (walking, cycling and public transport) compared with driving
- Valued the healthy liveable city using a hedonic pricing model
- Developed an Agent- and activity-based Transport model for Melbourne (AToM) to examine different active transport scenarios following different interventions, including:
  - creating a road network model in AToM that allows for detailed route-based travel itineraries suitable for walking and cycling (as opposed to pedestrians and cyclists 'teleporting', as was previously the case – see page 21)
  - developing a synthetic population of 'agents' with spatially relevant demographic characteristics
  - creating agent travel itinerary algorithms
  - trialling the AToM with 1% and 10% samples of Melbourne's population

- Interviewed transport planners and practitioners to support the development of active transport scenarios for testing in AToM
- Developed a series of interventions related to Melbourne's planned Suburban Rail Loop as a scenario for testing in AToM, to determine its effect on active transport, public transport use and driving
- Supported a PhD candidate to develop an agent-based model for cycling, and test various scenarios
- Presented the research at numerous forums, including a webinar with our Australian Government Department of Health research partners, detailing research plans and progress to date.

A major aim of the Healthy Liveable Cities Lab is to build capacity and future leaders in research on the built environment and health. For this Prevention Centre project, two team members have specifically been part of this capacity-building program. Mr Afshin Jafari joined the team as a PhD candidate in 2018 and has been a major contributor to our research on agent-based modelling, particularly on building a cycling model. As part of his PhD, Afshin, in collaboration with Drs Alan Both and Dhirendra Singh, developed the active transport network for the AToM, calibrated and validated the baseline model, developed the team's capability in using the AToM, extended the cycling simulation component of the baseline model, and used it to test a series of cycling scenarios. Afshin has done this research in collaboration with industry partners whom he and Dr Lucy Gunn interviewed to inform interventions for this project.

Carl Higgs was initially employed by the CRE-HLC to develop the Urban Liveability Index for Melbourne, in collaboration with Professors Hannah Badland and Billie Giles-Corti. However, through this work, and in working with Drs Jonathan Arundel and Koen Simons, Carl led the creation of liveability indicators nationally for every residential address point. He also developed the original prototype of a portal to disseminate liveability indicators that led to the development of the Australian Urban Observatory. In 2020, Carl enrolled in a PhD, for which he is focusing on the methods underpinning the team's national liveability indicator research. That research was upscaled internationally in a project on Bangkok's liveability by Professor Hannah Badland and Associate Professor Melanie Davern and funded by VicHealth, and then globally in 25 cities in 19 countries as part of the Global Healthy and Sustainable City-Indicators Collaboration, led by Professor Billie Giles-Corti and published in May 2022 in *The Lancet Global Health* series on Urban Design, Transport and Health.[28]

Mahsa Abdollahyar has contributed further to building the team's capacity, by joining us in February 2021 as an agent-based modelling analyst after Dr Alan Both moved to the JIBE (Joining Impact models of transport to the Built Environment) project. JIBE is a project of the NHMRC/Medical Research Council UKRI Built Environment and Health Program, and builds on the Prevention Centre's liveability and agent-based modelling research. It involves a collaboration with Cambridge University. Alan leads the modelling work in Australia, working with Dr Dhirendra Singh and the UK team, while Dr Lucy Gunn leads one of JIBE's work packages, modelling transport mode choice. In 2022, Mahsa began a PhD on the JIBE project. Similarly, Dr Tayebeh Saghapour joined the team as a post-doctoral fellow and worked on the Prevention Centre liveability project; she has become a research fellow on JIBE, working with Lucy on the work package she leads.

Assessing the liveability of Australia's 21 largest cities

As noted earlier, the current National Liveability Study upscaled earlier work supported by Prevention Centre projects. Urban liveability and its underlying indicators were measured and assessed in Australia's 21 largest cities, home to just under 80% of the nation's population. This comprises all Australian state and territory capital cities (Sydney, Melbourne, Brisbane, Perth, Adelaide, Canberra, Hobart and Darwin) and Australia's 13 largest regional cities (Gold Coast–Tweed Heads, Newcastle–Maitland, Wollongong, Sunshine Coast, Geelong, Townsville, Cairns, Toowoomba, Ballarat, Bendigo, Albury–Wodonga, Mackay and Launceston). The choice of cities was determined by their inclusion in the Federal Government's National Performance Framework for cities.[29]

Creating the liveability indicator database and specific indicators

OpenStreetMap and other routinely collected data were compiled to create the national liveability built-environment database (see Table 1 for the indicators). Using the 2018 Geocoded National Address File data as proxies for residential locations, we calculated built-environment measures for each of the proxy residential addresses in the 21 cities. Full details about how the liveability indicators were calculated are available elsewhere.[21,22] The resulting evidence-based indicators were visualised and made available through the Australian Urban Observatory (auo.org.au), which was launched in February 2020. More detail about the Observatory can be found on page 35.

Table 1. **Summary of 13 indicators included in the national urban liveability composite index, and the Australian Urban Observatory**

Indicator		Specific destinations		Scale at which measured
Social infrastructure				
1	Community, culture & leisure	Community centres		1,000 m
		Cinema / theatre		3,200 m
		Libraries		1,000 m
		Museums / art galleries		3,200 m
2	Education access	State primary schools		1,600 m
		State secondary schools		1,600 m
3	Health & social services access	Aged care		1,000 m
		Community health centres		1,000 m
		Dentists		1,000 m
		GP clinics		1,000 m
		Maternal/child health		1,000 m
		Pharmacy		1,000 m
4	Sport & recreation access	Swimming pools		1,200 m
		Sport/recreation facilities		1,200 m
5	Early years access	Childcare meeting quality requirements		
			any	800 m
			out of school hours	1,600 m
Food				
6	Fresh food access	Fruit/vegetable grocer		1,000 m
		Meat/seafood		3,200 m
		Supermarkets		1,000 m
Convenience amenities				
7	Convenience amenity access	Convenience store		1,000 m
		Newsagent		3,200 m
		Petrol station		1,000 m
Transport				
8	% dwellings with access to regular public transport	Public transport stops with average daytime weekday service frequency ≤ 30 minutes		400 m
Public open space				
9	% dwellings with access to large public open space (> 1.5 hectares)	Public open space entry point proxy locations		400 m
Walkability				
10	Street connectivity per km^2	Pedestrian network and intersections		1,600 m
11	Dwelling density per hectare	Pedestrian network and mesh block areas with dwelling counts		1,600 m
Housing				
12	Housing affordability	Housing expenditure by relative household income		Statistical Area 1
Employment				
13	Local employment	Place of work (ASGS Statistical Areas Level 3) by place of residence (ASGS Statistical Areas Level 1)		Statistical Area 1

Liveability scorecards

Liveability report scorecards for Australia's 21 largest cities were developed and disseminated through the Australian Urban Observatory for:

- Sydney
- Melbourne
- Brisbane
- Perth
- Adelaide
- Gold Coast–Tweed Heads
- Newcastle–Maitland
- Canberra
- Sunshine Coast
- Wollongong
- Geelong
- Hobart
- Townsville
- Cairns
- Toowoomba
- Darwin
- Ballarat
- Bendigo
- Albury–Wodonga
- Launceston
- Mackay.

Each report covers nine indicator domains with spatial maps at suburb-level geographies, as described in more detail in 'Translating research into action' (page 35). Specific domains included in the reports were:

- liveability
- walkability
- social infrastructure
- public transport
- food environment
- alcohol environment
- public open space
- employment
- housing affordability.

- **Publication for Melbourne scorecard**: Gunn LD, Davern M, Higgs C, Both A, Roberts R, Rozek J, Giles-Corti B (2020). *Measuring liveability for the 21 largest cities in Australia: Liveability report for Melbourne*. Melbourne: RMIT University, Centre for Urban Research.

Are there spatial and socioeconomic inequities in liveability in Australia's 21 largest cities: Does city size matter?

The philosophy of 'leaving no-one behind' underpins the United Nations' Sustainable Development Goals. In cities, this requires integrated policies across many sectors so that infrastructure, opportunities and services (that is, city-planning-related determinants of health) are distributed equitably. Inequitable access to these health determinants – reflected in the concept of 'urban liveability' – could generate, sustain and exacerbate socioeconomic and health inequities.

We examined spatial and area-level socioeconomic variation in access to urban liveability in Australia's 21 largest cities.

Spatial variation in average neighbourhood urban liveability was mapped and examined by quintiles of neighbourhood disadvantage across 39,967 residential statistical areas in Australia's eight state and territory capital cities and 13 most populous regional cities. Urban liveability was measured using a validated index incorporating access to social infrastructure, public transport, public open space, healthy food choices, and local employment, plus street connectivity, dwelling density, and housing affordability stress.

We found inequities in the liveability of neighbourhoods in Australian cities. Urban liveability varied spatially, with inner-city areas generally more liveable than outer suburbs. In Australia's largest capital cities (Sydney, Melbourne, Brisbane, Perth), disadvantaged areas were significantly less liveable than advantaged areas, but this pattern was reversed in smaller capital cities (Adelaide, Canberra, Darwin) and most regional cities.

Regardless of city size, city-wide averages of urban liveability masked inequities in access to health-supportive amenities, and outer suburbs were less liveable. However, our findings challenge assumptions about where, and for whom, socioeconomic inequities in liveability exist, with variability depending on city size. Local data is needed to: provide early-warning systems to avoid widening inequities; inform and benchmark policies and interventions; and provide data to inform investments and advocacy aimed at providing healthy liveable cities for all. Policies are also needed to avoid disadvantage being suburbanised as cities grow and gentrify.

- **Publication:** Giles-Corti B, Saghapour T, Turrell G, Gunn L, Both A, Lowe M, Rozek J, Roberts R, Hooper P, Butt A, Higgs C (under review). *Spatial and socioeconomic inequities in liveability in Australia's 21 largest cities: Does city size matter?*

Using the National Liveability Study data and methods in research on the built environment and health

The National Liveability Study has been part of a large, comprehensive liveability research program supported by funding from several grants (for example, the CRE-HLC and CAUL). By working across more than one grant project, we have amplified the return on the Prevention Centre's investment. For example, the CRE-HLC funded much of the conceptual and validation work and the development of the liveability index in Melbourne; the CAUL Hub funded the development of policy-relevant indicators for the report *Creating Liveable Cities in Australia* and, with additional funding from the Victorian Department of Health, explored the relevance of liveability indicators to regional Victorian cities; the Healthy Liveable Cities Lab through funding from the RMIT University Urban Futures Enabling Capability Platform disseminated liveability indicators to Victorian local government authorities; and the Prevention Centre funded validation work nationally. It also upscaled and disseminated of the liveability work nationally, and established the Australian Urban Observatory with co-funding from the CRE-HLC and RMIT's Urban Futures Enabling Capability Platform.

Creating geospatial datasets for studies of health and the built environment is time-consuming and costly. In a resource-constrained environment, limited budgets are often spent on collecting data, rather than on analysing data and doing research. Hence, in partnership with the Prevention Centre leadership team, it was always envisaged that the National Liveability Study would become a 'legacy project', by creating and disseminating the indicators through the Australia Urban Observatory for application by policy makers and practitioners, as well as by making the data which was used to create the indicators available for use in other research.

This latter vision was realised by the decision to develop comparable geospatial data for every residential address point in Australia's 21 largest cities, which are home to almost 80% of Australians. This has meant that the measures of built-environment exposure that our team developed could be readily linked to health data for participants in other studies. Rather than remaining on our computers for use by our team only, the rich dataset of built-environment exposure measures for more than 6 million residential address points has already been used in a host of other studies, saving hundreds of thousands of research dollars (see Table 2).

But this is only the beginning. The 21 cities' parcel-level dataset has now been uploaded onto the open-source repository Figshare, where it will shortly be available for any other research group.[30] Studies of the built environment and health require temporally relevant geospatial data (that is, geospatial data collected for the same period as the survey data). Hence, in the next section, we describe how the methods for measuring local neighbourhood liveability at scale have been extended as open-source software for use in cities around the world, enabling groups to readily replicate and extend our methods to create new and up-to-date datasets.

Table 2. Use of the 21 cities national liveability data in other research

Study name	Lead investigators for linked data	Funded by	Study period	Data linked to	n	Study location	Publications and dissemination
The Australian Diabetes, Obesity and Lifestyle Study (AusDiab)	Giles-Corti B Owen N Sugiyama T	NHMRC CRE-HLC (#1061404)	2016–ongoing	AusDiab Study	4,614	National	Ref. 31
Development of the Urban Liveability Index	Badland H Giles-Corti B	NHMRC CRE_HLC (#1061404)	2017–21	Victorian Integrated Survey of Transport and Activity (VISTA) 2012–16 Victorian Public Health Survey§	12,323 8,691	Melbourne	Ref 21,22 Index for 21 cities through Australian Urban Observatory
Data to Decisions: Australian Early Development Census – Built Environment Study Also used for Examining the Relationship Between the Neighbourhood Built Environment and Mental Health in Early Childhood§	Villanueva K Badland H Goldfeld S	Bernard van Leer Foundation Australian Government Department of Social Services Australian Government Department of Education, Skills and Employment	2017–ongoing	Australian Early Development Census	235,000	National	Ref. 32,33 Papers currently under review ARC Discovery Grant under review

Study name	Lead investigators for linked data	Funded by	Study period	Data linked to	n	Study location	Publications and dissemination
NHMRC CRE in Disability and Health	Badland H Kavanagh A	NHMRC GNT1116385	2016–22	Australian Bureau of Statistics Census data Multi-Agency Data Integration Project Basic Longitudinal Extract 2011–16 cohorts	Ecological	National	Ref. 34,35
High Life	Foster, S	ARC, Healthway	2016–ongoing	High Life survey on apartment living and health	1,200	Perth Melbourne Sydney	Ref. 36
Changing Children's Chances	Badland, H	ARC LP190100921	2017–24	Longitudinal Study of Australian Children Wave 7	2,650	National	None as yet

§ PhD candidate project; Ref. = reference

Key research projects

Research led by Carl Higgs, data scientist and doctoral researcher, Healthy Liveable Cities Lab, RMIT University

- *Supervisors: Billie Giles-Corti, Dhirendra Singh, Jonathan Arundel, Claire Boulange*

Carl has worked with the Healthy Liveable Cities Lab team since 2015 and enrolled in a PhD in 2020. His interdisciplinary PhD refines, formalises and extends a scalable framework for calculating spatial indicators, with applications for benchmarking and monitoring urban environments to support creating healthier, more liveable cities. Through this research, Carl aims to develop software and tools for calculating, using and sharing spatial indicators of urban liveability, according to an open-science ethos, for use by researchers, practitioners and policy makers.

Through the Urban Liveability Index project[22,37,38], Carl developed a generalised, flexible software framework to measure local neighbourhood residential liveability for residential addresses at scale, to enable detailed analysis and visualisation of the distribution of liveability and its components in cities (Figure 1.1). This was applied to capital and regional cities, towns and local government areas around Australia (the Australian National Liveability Study, 2016–2021)[25,39-43] and to 25 cities around the world, through two projects (Bangkok Liveability, 2018–21[44] and Global Healthy and Sustainable City-Indicators Collaboration study, 2018–22).[45] The results to date have been used for scorecard reports of urban liveability[44], interactive indicator map portals[42,45], analysing behaviour and health[33,34,36,46,47] and providing amenity in new urban developments.[48] They have also been extended for evaluating policies to meet the needs of specific population subgroups, including children[33] and the elderly.[49] Open-source software has been developed to support spatial analysis of urban liveability for cities in various contexts, using open and custom data.[50]

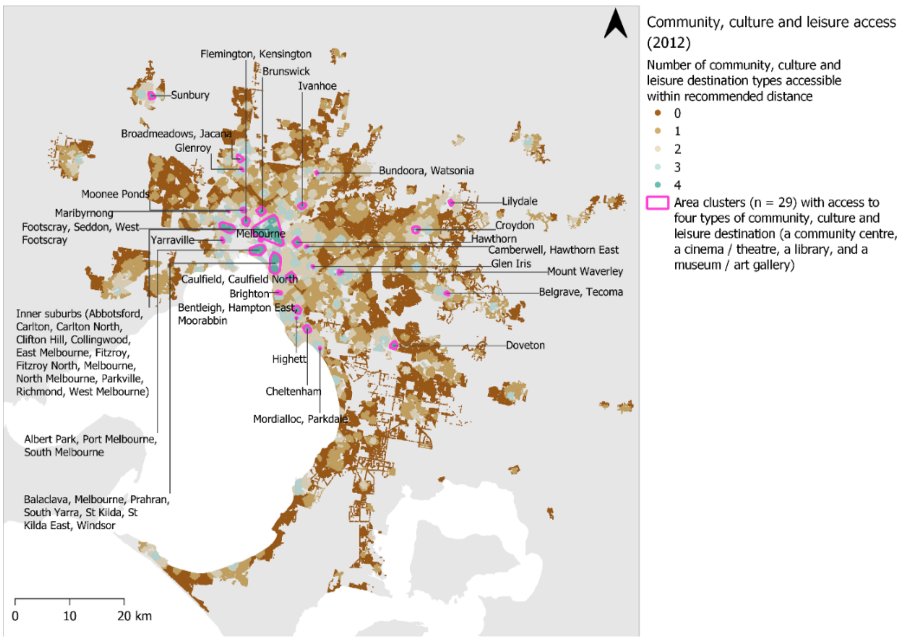


Figure 1.1 Spatial distribution of access to a mix of community, culture and leisure destinations, which was found to be associated with a range of cardiometabolic health benefits, reflecting the benefits of amenity-rich, mixed-use neighbourhoods[22]

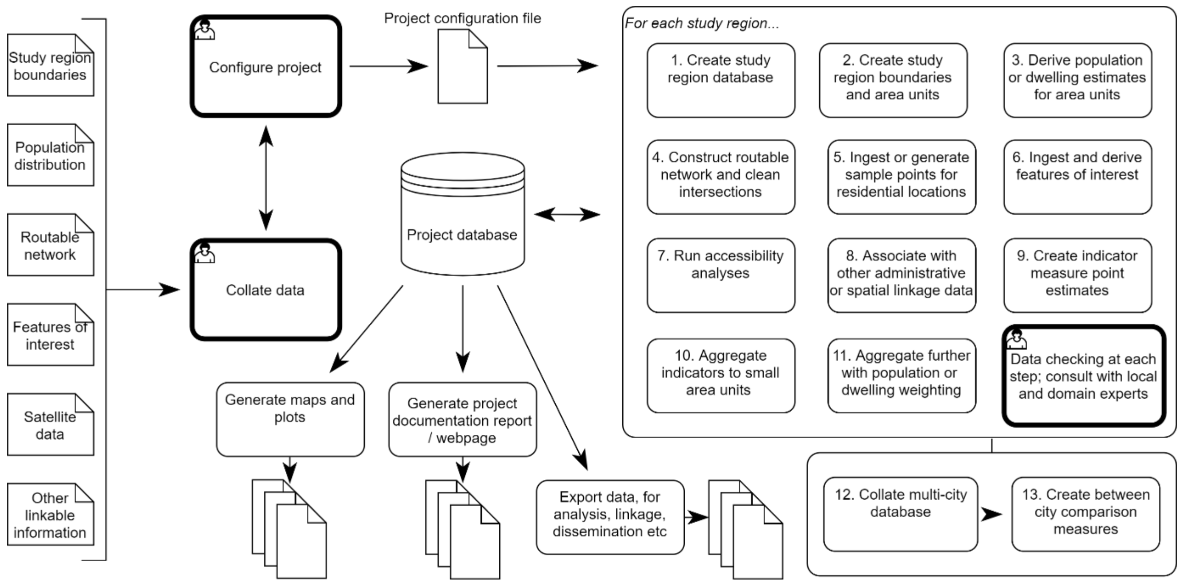


Figure 1.2 A generic software framework for calculating, validating, analysing and disseminating spatial urban indicators

In the next two years, Carl aims to refine the methods, software and outputs developed to date, to help other researchers use them to monitor progress across time, make meaningful comparisons within and between cities, and promote reproducibility and generalisability of liveability indicators. This will help researchers in sustainability, ecology and social cohesion to extend the framework for use in diverse contexts and to perform self-documenting analyses using open-source software to strengthen the quality and depth of future liveability research.

This work won a commendation in the Planning Institute of Australia's Award for Planning Excellence in Victoria for Planning Research in 2021.

Cross-sectional evidence of the cardiometabolic health benefits of urban liveability in Australia

Around the world, people are recognising that urban planning that makes neighbourhoods more liveable leads to healthy sustainable lifestyles and helps prevent and manage chronic disease.

The research team presented the spatial Urban Liveability Index as a tool to inform localised interventions that would create healthier, more sustainable cities, and we examined the Index's associations with wellbeing and cardiometabolic health.

The Urban Liveability Index and associated indicators for Melbourne address points were calculated and spatially linked with data from the 2014 Victorian Population Health Survey.

The study found that living in a more liveable area is positively associated with a more physically active lifestyle, and negatively associated with body mass index. These associations are closer than those for a comparable walkability index.

Although walkable neighbourhoods underpin a liveable city, areas with diverse community, culture and leisure destinations displayed strongest beneficial associations with cardiometabolic health, suggesting that access to diverse local destinations may encourage more active, sustainable living.

- Publication: Higgs C, Simons K, Badland H, & Giles-Corti B (2021). *Cross-sectional evidence of the cardiometabolic health benefits of urban liveability in Australia*. NPJ Urban Sustainability 1(1), 1–13.

Policy-relevant spatial indicators of urban liveability and sustainability: scaling from local to global

Urban liveability is a priority for creating healthy, sustainable cities around the world. Measuring policy-relevant spatial indicators of the built and natural environments supports city planning at all levels of government. Analysing these indicators' spatial distribution in cities, and their effects on individuals and communities, is crucial for effective and equitable planning decisions.

This paper described problems and lessons from a five-year collaborative research program that scaled up a software workflow for calculating a composite indicator of urban liveability for residential address points, from Melbourne to Australia's 21 largest cities, and its further extension to 25 diverse cities around the world.

- **Publication:** Higgs C, Alderton A, Rozek J, Adlakha D, Badland H, Boeing G, Both A, Cerin E, Chandrabose M, De Gruyter C, De Livera A, Gunn L, Hinckson E, Liu S, Mavoa S, Sallis JF, Simons K, Giles-Corti B (2022). Policy-relevant spatial indicators of urban liveability and sustainability: Scaling from local to global. Urban Policy and Research. Special Issue: 2021 State of Australasian Cities Conference.

A policy-relevant, health-related liveability indicator database for residential addresses in Australia's 21 largest cities

Abstract: Understanding the spatial distribution of liveability indicators is crucial if planning decisions and their implementation are to be effective, equitable and tracked across time. The 2018 Australian National Liveability Study dataset comprises policy-relevant spatial indicators of local neighbourhood liveability and access to amenities, for residential address points in Australia's 21 most populous cities. The indicators and measures encompass community and health services, employment, food, housing, public open space, transportation, walkability and overall liveability.

This national baseline dataset of liveability indicators is provided in geopackage and SQL formats, and will be of interest to planners and researchers in population health and cities who are concerned about the spatial distribution of built-environment exposures and outcomes. It will be useful for linking to survey and other data, modelling and mapping.

- **Publication:** Higgs C, Rozek J, Roberts R, Both A, Arundel J, Hooper P, Villanueva K, Simons K, Mavoa S, Gunn L, Badland H, Davern M, Giles-Corti B (in preparation). *A policy-relevant, health-related liveability indicator database for residential addresses in Australia's 21 largest cities*.

Research led by Afshin Jafari, PhD student, Healthy Liveable Cities Lab, RMIT University

- *Supervisors: Billie Giles-Corti, Dhirendra Singh, Jonathan Arundel, Claire Boulange*

Cycling for transportation offers a promising solution to several major problems of today's unhealthy and unsustainable lifestyles in rapidly urbanising cities – from obesity and chronic diseases to congestion and air pollution. Increasing the share of bicycle use requires a supportive environment and well-designed cycling infrastructure. However, due to the heterogeneity of cycling behaviour, designing interventions that will promote cycling is not easy.

In his PhD, Afshin created a city-scale agent-based simulation model for cycling for transport in Greater Melbourne. Planners can use this model to test different interventions, such as adding a bike lane, to examine their possible consequences for cycling mode share and cyclists' travel behaviour, and to help decision-makers prioritise investment in cycling infrastructure. This model is the first of its kind in Australia and has already gained much interest from planners and transport modellers in Melbourne.

A multi-step approach was used to design, develop and implement the simulation model. The first step involved statistical analyses of secondary data from travel surveys, the 2016 census and smartphones, to better understand the factors associated with cycling behaviour in Melbourne. The analysis showed that demographic factors such as gender and employment status, road infrastructure attributes such as bikeway availability and road elevation, and intersection attributes such as traffic signals, were all associated with Melburnians' decisions about whether to cycle, and their choice of routes when riding a bicycle.

A review of existing models for Melbourne revealed a need for a model that included minor roads typically used by cyclists (and pedestrians) in the road network, as well as attributes important for cyclists such as bikeway type and elevation. Typically, agent-based models 'teleport' cyclists and pedestrians; that is, they include only the major arterial roads used by motor vehicles and public transport. Afshin developed a novel open-source algorithm to generate the required road network model, based on publicly available data such as OpenStreetMap, GTFS (General Transit Feed Specification) and Digital Elevation Models. He used the algorithm to build the road network model of Melbourne for use as an input to the agent-based simulation model. This method could be used to build similar networks for other cities around the world.

The first agent-based model in Afshin's thesis was the 'Activity-based and agent-based Transport model of Melbourne' (AToM) baseline. AToM is an open-source, multi-modal, agent-based transport simulation model that simulates a single day of Melbourne's transport system with a population sample of 10%. The mode-choice function was calibrated for all four main modes of travel – car, public transport, walk, bicycle – so that the model can examine transport mode choice of Melbourne travellers in different scenarios, and the intended and unintended consequences for the transport system. Working with Dr Lucy Gunn, Afshin interviewed more than 20 senior planners and decision-makers to understand how his model might help solve real-world problems, and to find high-impact strategic interventions to test with the simulation model.

The first intervention that was tested with the simulation model was to investigate the effects of eliminating delays caused by traffic signals for cyclists on selected major cycling corridors around Melbourne's central business district during the morning peak. Firstly, a random forest prediction model was used to find physical environment factors that had the greatest effect on cycling speed and to predict the speed for all road segments in Greater Melbourne. Aggregated and de-identified smartphone data from Strava Metro, along with automated cycling volume and speed-sensor data from the Department of Transport, were the main sources used to train and test the random forest model. Then, the AToM baseline was extended by incorporating the effects of physical environment attributes (built-environment factors such as bikeway type and natural environment factors such as slope) on agents' cycling speed. Five main cycling corridors into Melbourne's central business district were tested.

The second extension to the AToM baseline was adding different mobility-behaviour models for agents from different demographic cohorts. To achieve this, first, a K-means clustering was used for the different age and sex groups of cyclists from the Victorian Integrated Survey of Travel and Activity (VISTA). Measures for clustering were how far and for how long survey participants cycled. Four clusters were identified, and the parameters of the mode-choice model were estimated separately for each cluster. As a result, cycling agents had a different mode-choice model based on their age and gender. This model was used to examine the effects of a city-wide implementation of Melbourne's strategic cycling corridors (a series of existing and proposed bikeways connecting cyclists to major destinations in Greater Melbourne).

The methods and models introduced in this thesis fills a gap by providing a reliable, large-scale, agent-based model of cycling for transport in Melbourne. Furthermore, it offers a reproducible and open workflow for developing such models for other cities around the world. In future, the models could be extended to include the influence of the social environment on cycling behaviour, and also newer modes of transport such as e-bikes and e-scooters. They could also incorporate the health, economic and environmental consequences of changes in bicycle use due to built-environment interventions. This is necessary to build the case for expediting new cycling infrastructure, thereby increasing the uptake of cycling and moving towards an active and sustainable transport system.

Throughout his PhD, Afshin has worked with policy makers and practitioners to make his research relevant. Feedback from policy makers suggests that it has already been influential. For example, the Active Modes and Amenity Team of the Department of Transport's metro south-east (MSE) region found Afshin's work to be "particularly helpful in reviewing at a tactical level a range of existing bicycle infrastructure locations in MSE and identifying and prioritising network level gaps".

- Publications: Jafari A, Singh D, Boulange C, Giles-Corti B, & Arundel J (2019). *Towards a utilitarian agent-based model of cycling in Melbourne*. Journal of Transport and Health 14: Supplement: 100727.
- Jafari A, Singh D, & Giles-Corti B, *Understanding the cycling behaviour in Melbourne, Australia, through analysis of multiple data sources*. Journal of Transport and Health 22: Supplement: 101187.

Building the road network for city-scale active transport simulation models

City-scale simulation modelling of active modes of transportation (walking and cycling) has become increasingly popular in recent years.

The heterogeneous and complex behaviour of these transportation modes reveals the need to shift from traditional modelling based on car and public transport use, towards models that incorporate the requirements for walking and cycling behaviour, while maintaining the run-time efficiency of the models.

We introduced and tested our algorithm to create road network representations, designed and optimised to be used in city-scale modelling of active transportation. The algorithm relies on open and universal data. In addition to the major roads and attributes typically used in transport modelling (such as speed limit, number of lanes, and permitted travel modes), the algorithm captures minor roads usually favoured by pedestrians and cyclists, along with road attributes such as bicycle-specific infrastructure, traffic signals, road gradient and road surface. Furthermore, it simplifies the complex geometries of the network and merges parallel roads, if applicable, to make it suitable for large-scale simulations. To examine the utility and performance of the algorithm, the research team used it to create a network representation of Greater Melbourne and compared the results with a network created using an existing simulation toolkit, along with another network from an existing city-scale transport model from the Victorian Government.

Through simulation experiments with these networks, the research illustrated that, for routed trips on the network for walking and cycling, it is comparable in accuracy to the common network conversion tools in terms of travel distance of the shortest paths, while being more than two times faster when used for simulating different sample sizes. Therefore, the algorithm offers users a flexible and adjustable way to create road networks for city-scale active transport modelling, while balancing simulation accuracy and run-time.

- Publication: Jafari A, Both A, Singh D, Gunn L, Giles-Corti B (2022). *Building the road network for city-scale active transport simulation models*. Simulation Modelling Practice and Theory 114: 102398.

Activity-based and agent-based Transport model of Melbourne (AToM): An open multi-modal transport simulation model for Greater Melbourne

Agent-based and activity-based models for simulating transportation systems have attracted significant attention in recent years. Few studies, however, include a detailed representation of active modes of transportation – such as walking and cycling – at a city-wide level, where dominating motorised modes are often of primary concern.

In this research, an open workflow was designed for creating a multi-modal, agent-based and activity-based transport simulation model. It focused on Greater Melbourne and included the process of calibrating mode choice for the four main travel modes: driving, public transport, cycling and walking.

The synthetic population that was generated and used as an input for the simulation model represented Melbourne's population based on Census 2016, with daily activities and trips based on data from Victoria's 2016–18 travel survey. The road network included all public roads accessible using the four travel modes. The study compared the output of the simulation model with observations from the real world, in terms of mode share, road volume, travel time, and travel distance. Through these comparisons, it showed that the model is suitable for studying travellers' mode choice and road-use behaviour.

- Publication: Jafari A, Singh D, Both A, Abdollahyar M, Gunn L, Pemberton S, & Giles-Corti B (2021). *Activity-based and agent-based Transport model of Melbourne (AToM): An open multi-modal transport simulation model for Greater Melbourne*. arXiv preprint arXiv:2112.12071.

Using a random forest model to understand the effects of road and junction attributes on cycling speed for city-scale agent-based simulations

Cycling to work and daily destinations, known as cycling for transport, is a sustainable and active alternative to using motorised vehicles. A salient characteristic of transport trips, however, is that the traveller typically prefers to spend less time travelling and to reach the destination sooner. Thus, it is important to understand the main causes of delays for cyclists, and to examine the potential consequences of removing those factors on cycling travel behaviour.

Agent-based simulation models can be used to test changes in cyclists' behaviour across a city. However, few studies have examined factors causing delays for cyclists at a large scale, and fewer are city-scale simulation models incorporating heterogeneous speeds for cycling. This study used two different prediction models – a simple linear regression model and a random forest model – to discover which road attributes affect cycling speeds in Melbourne.

The random forest model showed a higher prediction and therefore was used for further analyses and to predict cycling speed for all road segments across Greater Melbourne. The variable importance analysis of the random forest model showed that the signalised intersection had the most significant effect on cycling speed among all road attribute factors included. The research team used the predicted network to build an agent-based, multi-modal simulation model with heterogeneous cycling speed for Melbourne. Using the simulation model, the study tested the potential gain of removing delays caused by traffic signals for cycling along several of Melbourne's cycling corridors. The simulation outputs showed that this intervention could result in up to an 11.1% increase in cycling volume on these corridors, and a potential travel time reduction of up to 9.5%.

- **Publication:** Jafari A, Singh D, Gunn L, Collins N, Both A, & Giles-Corti B (under review). *Using random forest to capture the impact of road and junction attributes on cycling speed for city-scale agent-based simulations.*

Using agent-based modelling to examine the potential effects of citywide cycling corridors on cycling for transportation in Melbourne

Regular cycling to reach daily destinations provides a promising solution to many problems of urban living, from traffic congestion and air pollution to sedentary lifestyles and cardiovascular diseases. The existence of dedicated cycling infrastructure or bikeways, and the connectivity of these bikeways to form a network of corridors to reach a person's main daily destination, can encourage more people to cycle, and enable less confident cyclists to cycle for their daily trips.

In this study, we developed a large-scale, agent-based simulation model for cycling in Melbourne, and applied it to study the effects of greater bikeway connectivity on cycling behaviour. A K-means algorithm was used to cluster different demographic groups of cyclists according to distance they cycled and for how long (using Victoria's travel survey data). Then, the research team separately estimated coefficients for the mobility-behaviour function of the agent-based model for each cluster. These cohort-based functions enabled the team to use the simulation model to model and study the heterogeneous travel behaviour of different cohorts of cyclists. The simulation model was then used to test the effects of adding a network of city-wide connected bikeways connecting major destinations, known as Melbourne's Strategic Cycling Corridors. We used OpenStreetMap to identify Melbourne's existing roads and bikeways.

The before-and-after comparison showed that there is a potential to increase cycling mode share in all demographic groups on average by 130.8%. The highest increase (154%) is for the clusters composed mostly of middle-aged male and female cyclists.

The findings suggest that greater bikeway network connectivity across the city and to major destinations can significantly increase the uptake of cycling as a mode of transport.

- **Publication:** Jafari A, Singh D, Saghapour, T, Pemberton S, Both, A, Gunn, L, Giles-Corti B. (in preparation). *Using agent-based modelling to examine the potential impact of implementing city-wide cycling corridors on cycling for transportation in Melbourne*.

Scaling up the National Liveable Cities methodology: From local to global

The challenges of undertaking and comparing built environment and health studies include identifying appropriate data, developing appropriate methods, and the need to create comparable geospatial indicators. The methods developed for the report *Creating Liveable Cities in Australia*[25] have therefore been upscaled and further developed in other international studies (see Table 3).

The methods were first adapted for use outside Australia in software developed by Carl Higgs for monitoring the spatial distribution of liveability in Bangkok, Thailand, in collaboration with the Bangkok Metropolitan Administration.[37-39] They were then generalised for broader use in other cities around the world, using open data, as part of the Global Healthy and Sustainable City-Indicator Collaboration, which involved more than 80 collaborators, in 25 cities in 19 countries, on six continents. For this global study – published as *The Lancet Global Health* series on Urban Design, Transport and Health[28,40-43] – spatial indicators for residential neighbourhoods were developed using open data in 25 cities, in collaboration with local experts. Policy analysis – also replicating methods developed through *Creating Liveable Cities* – was undertaken in partnership with local collaborators in 25 cities, led by Dr Melanie Lowe (University of Melbourne), who also worked on *Creating Liveable Cities*.

The Australian cities of Adelaide, Melbourne and Sydney were included in the global study. The open-source methods developed to create these indicators have been described in the literature, with open-source tools published on GitHub to enable other researchers and cities to replicate and expand the indicators developed for this project.[44] In addition, data developed for the Global Indicators study have been published on Figshare, for use in other research.

Prevention Centre co-funding enabled Carl Higgs to work on this project, which included research-translation work to summarise findings for the 25 international cities across 46 reports in 16 languages, to involve local communities and decision-makers. The open-source software used to coordinate translations and layout of the reports is located at https://github.com/carlhiggs/global_scorecards The reports are being used by collaborators in many of the 25 cities to launch the local results among policy makers and practitioners, and are being disseminated through the Global Observatory of Healthy and Sustainable Cities (https://www.healthysustainablecities.org/), hosted by Washington University in St Louis.

Table 3: Use of the 21 cities national liveability methodologies in other research studies

Study name	Funded by	Investigators	Study period	Study location	Publications and dissemination
Measuring, Monitoring and Translating Urban Liveability in Bangkok	VicHealth Sustainable Development Goals Partnership Grant	Alderton A, Higgs C, Davern M, Badland H	2018–21	Bangkok	Ref. 37-39 Higgs C, Alderton A, Nitvimol K, Badland H (2022). *Bangkok Liveability – Release 1.2*. RMIT University. Report. https://doi.org/10.25439/rmt.19976126 Higgs C (2022). Training video for Bangkok Liveability. RMIT University. Media. https://doi.org/10.25439/rmt.19976123 Higgs C (2022). Bangkok Liveability v1.2 software framework. RMIT University. Software. https://doi.org/10.25439/rmt.19977116
Global Healthy and Sustainable Cities-Indicator Collaboration	Multiple sources from collaborators including NHMRC and RMIT University	Higgs C, Liu S, Boeing G, Arundel H, Lowe M, Adlakha D, Cerin E, Hinckson E, Sallis JF, Salvo D, Vernez Moudon A, Giles-Corti B	2018–22	25 cities, in 19 countries, on 6 continents	The study has been published as *The Lancet Global Health* series on Urban Design, Transport and Health.[28,40,42,43,45] Methods for developing open-source tools to measure liveability indicators globally have also been published,[44] along with open-source software available in GitHub (https://github.com/global-healthy-liveable-cities/global-indicators). Data from the study is available on Figshare,[46] in addition to 46 reports in 16 languages disseminated through the Global Observatory of Healthy and Sustainable Cities https://www.healthysustainablecities.org

Measuring accessibility to employment, to create a 30-minute city

To help maintain the liveability of rapidly growing and congested cities, different models of urban development are being proposed. Victoria proposes a city of '20-minute neighbourhoods', with all essential shops and services (except employment) within a 10-minute walk from home.[26] New South Wales (NSW) proposes a '30-minute city', in which most people have jobs, education and health facilities within a 30-minute walk or public transport trip.[47] It is plausible that creating '20-minute neighbourhoods in a 30-minute city' will achieve the greatest health and environmental benefits, by increasing access to amenities *and* employment and enabling walking, cycling and public transport use for local and commuting trips, while reducing driving and commuting time.[4] Yet all these models are untested. Most of the Healthy Liveable Cities Lab's work is related to achieving the 20-minute neighbourhood, and indeed our team's research has been incorporated into the concept in Victoria. However, in the following study we examined the feasibility of achieving active 30-minute cities through access to employment.

Achieving 'active' 30-minute cities: how feasible is it to reach work within 30 minutes using active transport?

The 30-minute city – where employment is accessible within a 30-minute walk or public transport trip for most residents – is being pursued by policy makers in some cities, to foster local living and relieve congestion.

The study aimed to answer three questions about commuters in Australia's 21 largest cities:

1. What percentage currently commute to their work within 30 minutes?
2. If commuters were to shift to active transport, what percentage could reach their current workplace within 30 minutes?
3. If it were possible to relocate employment closer to home, what percentage of commuters could get to work within 30 minutes?

We estimated travel times for walking, cycling, and driving trips to work, based on Australian Bureau of Statistics data and according to hypothetical scenarios of whether residents could shift either their homes or jobs to be within a 30-minute limit.

Active transport mode share in Australia's cities is low, with public transport, walking and cycling making up 16.8%, 2.8%, and 1.1% respectively of commuting trips. We found that, of the active transport modes, cycling has the most potential for achieving the 30-minute city, with 29.5% of workers able to reach their current workplace if they cycled, and 69.1% if they were also willing and able to find a job closer to home.

Achieving an 'active' 30-minute city will require both a shift to active transport and the redistribution of employment to bring jobs closer to where people live. Together, this would reduce commuting by private motor vehicle from 79.3% to 30.9%.

- **Publication:** Both A, Gunn L, Higgs C, Davern M, Jafari A, Boulange C, Giles-Corti B (2022). Achieving 'active' 30 minute cities: How feasible is it to reach work within 30 minutes using active transport modes? *ISPRS International Journal Geo-Information 11*, 58. https://doi.org/10.3390/ijgi11010058.

Agent- and activity-based modelling

An agent-based model is a computerised simulation of a number of agents (such as people or vehicles) that interact through a set of algorithms or rules. The models provide a foundation for simulation experiments in a virtual laboratory, which allow us to test the system-wide effects of scenarios of interest. An activity-based model uses demand to schedule activities for individual agents. This project combined agent-based and activity-based models.

For this modelling work, agents represent individual people who use a network of streets in Melbourne to travel from an origin – such as their home – to a destination related to work or education, by either walking, cycling, public transport or private vehicle (such as a car). The agents schedule their daily activities through an activity-based model, which is an algorithm that scores activities based on the time-cost of travel and demographic information such as age and sex, among other factors.

Drawing upon the expertise of RMIT's School of Computing Technologies through Associate Professor Dhirendra Singh, and using the leading open-source transport simulation platform MATSim, we constructed an Activity-based and agent-based Transport model of Melbourne (AToM) that can be used to simulate individual-level walking, cycling, public transport and private vehicle daily use in Melbourne. This research built on an agent-based modelling simulation provided to us by our research partner Infrastructure Victoria. That model was originally developed by KPMG to simulate the use of autonomous and electric vehicles. After trial, we found that it was unable to account for the active transport modes of walking, cycling and public transport, which were our primary interest.

Hence, before we could begin our research, we had to create a model suitable for evaluating active transport scenarios for walking, cycling and public transport. These modes contribute to physical activity levels and population health, yet they have not been included in Australia's previous agent- or activity-based models. This set the research team on the path to create AToM.

The main research components of our AToM project were:

- creating a road network to accommodate active transport
- upgrading algorithms for assigning agent profiles, known as a 'virtual population'
- an application for city-scale simulation model development, calibration and case studies.

Before modelling of scenarios, we needed to do a considerable amount of methodological work to build the model. Afshin Jafari's PhD research was instrumental in developing the models used throughout this project. More detail on each component is detailed in the following sections and a summary of these research projects is presented in the sections here.

An activity-based model of transport demand for Greater Melbourne

In this project, we presented an algorithm for creating a synthetic population for the Greater Melbourne area, combining hierarchical clustering, probabilistic, and gravity-based approaches.

We combined these techniques in a hybrid model with three primary innovations:

1. When assigning activity patterns, we generated individual activity chains for every agent, tailored to its cohort.
2. When selecting destinations, we aimed to balance the distance-decay of trip lengths with the activity-based attraction of destination locations.
3. We took into account the number of trips remaining for an agent, so that they did not select a destination that would be unreasonable to return home from.

Our method is completely open and replicable, requiring only publicly available data to generate a synthetic population of agents compatible with commonly used agent-based modelling software such as MATSim. We found the synthetic population to be accurate in terms of activity type, start and end times, and duration, along with mode and destination choice, and distance distribution, for a variety of population sizes.

We successfully generated a synthetic population with the demographic characteristics of the Australian Bureau of Statistics census, and travel behaviour from the VISTA travel survey, in terms of distance distribution, mode choice, and destination choice. Synthetic populations provide a realistic input for agents, to use in simulation models of transport behaviour that go beyond replicating individuals from survey data to generating new virtual individuals.

- **Publication:** Both A, Singh D, Jafari A, Giles-Corti B, & Gunn L (under review). *An activity-based model of transport demand for Greater Melbourne*.

Melbourne’s Suburban Rail Loop

The Suburban Rail Loop (SRL) will be a 90 km orbital rail line connecting Melbourne’s middle suburbs to the existing rail network, offering a turn-up-and-go level of service, with trains arriving every 2–6 minutes. It will be built in three stages, for the eastern, northern and western sections of the city. The first stage will be the eastern section, linking Cheltenham train station on the Frankston line to Box Hill station on the Lilydale line. This section of rail will connect six existing and new train stops: Cheltenham, Clayton, Monash, Glen Waverley, Burwood and Box Hill. Planning for the eastern section includes development of the train station precincts within a 1600 m distance – a distance typically associated with 15–20 minutes of brisk walking, which also aligns to the 20-Minute Neighbourhood Planning Initiative in Melbourne’s strategic planning framework, which was initially set out in *Plan Melbourne* and *Plan Melbourne Refresh* by the Victorian Department of Environment, Land, Water and Planning.

Modelling by the Suburban Rail Loop Authority, described in its *Suburban Rail Loop Business and Investment Case* (released in August 2021)[48], predicts a $58.7 billion increase in economic, social and environmental benefits to Victoria over the lifetime of the project. However, the potential health benefits of the SRL have not been considered, motivating our interest given its strategic importance and potential for enabling active and public transport use across Melbourne – particularly in the under-served middle suburbs.

As part of this project, we developed the AToM model further, to measure explicit changes in active and public transport behaviour and driving that might result from the introduction of the SRL.

This work has resulted in two publications so far. The first details the development of the AToM model for use with the SRL case study. We compared a baseline scenario of the existing rail network with the first scenario (which introduced the SRL) and with a second scenario (which included the predicted densification of neighbourhoods in the new precincts around the six train stations on the eastern section). In the second publication, we explored the walking and subsequent health benefits accruing to the agents in our model from having improved rail network access via the SRL.

We summarise these publications below.

Developing an agent- and activity-based model to evaluate active transport effects of Melbourne’s proposed Suburban Rail Loop

Melbourne, the capital city of Victoria, Australia, currently has a radial train network, not geared to cross-city transit. To remedy this, the Suburban Rail Loop (SRL) has been proposed as an orbital system that will cover the under-serviced middle-ring suburbs. Currently there is limited modelling capability for measuring the effectiveness of the SRL for influencing cross-city transit. We developed, enhanced and applied our AToM to estimate walking and public transport use, thus testing the effects of the SRL on travel behaviour and health.

We developed the existing AToM model to include mode shifts and differences between age and sex groups as five cohorts of travellers. AToM II included an additional step for generating trip plans, which assigned train stations based on travel distance to public transport stops. AToM II was calibrated and validated using travel survey data from the Victorian Government Department of Transport, so that travel behaviour was modelled accurately. It was then tested using three scenarios: a baseline of existing rail infrastructure; with the SRL Stage 1 rail network; and with population increases in SRL Stage 1 train station precincts.

AToM II was successfully calibrated and validated using existing data sources. Results from the simulation modelling suggest that the SRL will increase active transport use in areas surrounding the SRL and across the city. The SRL increased active transport, particularly near the SRL Stage 1 area, even under the strong modelling assumption that SRL precincts do not add new destinations or places of employment for the weekday population.

AToM II adequately captured transit behaviour and could demonstrate mode shift from driving to public transit. City-wide results were modest, but suggested that the SRL alone (that is, with no other interventions) would increase use of active transport, leading to more sustainable and healthier cities. However, the success of the SRL and its effects may depend on the additional interventions yet to be modelled, which would reduce demand for driving.

- **Publication:** Abdollahyar M, Both A, Jafari A, Pemberton S, Gunn L, Giles-Corti B, & Singh D (in preparation). *Development of an agent- and activity-based model to evaluate active transport impacts of a major infrastructure investment in Australia: The Suburban Rail Loop*.

Measuring the health consequences of the Suburban Rail Loop using an agent- and activity-based model

In previous research we enhanced the AToM to accommodate walking behaviour, demographics, and mode shift. In this study we used AToM II to estimate the amount of walking and public transport use when applied to a case study of the SRL in metropolitan Melbourne, to examine health effects of active transport behaviour.

We developed two simulation scenarios. The first incorporated Stage 1 of the SRL, which involves six train stations (Cheltenham, Clayton, Monash, Glen Waverley, Deakin, and Box Hill), and the second scenario measured the effects of population increase in the train station precincts. The results of these two scenarios were compared to a baseline scenario of existing rail infrastructure, with mode shift and walking as the main quantities measured.

The SRL has been marketed as city-shaping infrastructure, and our results indicate that travel behaviour does shift towards the active modes of walking and public transit near the SRL Stage 1 area, with a small percentage of car drivers shifting to walking and public transit use. Across the entire city, the modelling showed that trips with an element of car use would decrease by around 1% , while trips with an element of public or active transport use would each increase by around 1% . Larger decreases and increases of around 2.5–3% were found for a targeted subset of trips that the SRL is particularly well placed to serve.

Our modelling showed that major infrastructure projects can influence city-wide active transport behaviour and lead to more walking and public transport use, thus leading to a more sustainable and healthier city. However, our scenarios showed only modest effects under some very strong simplifying assumptions about travel patterns and with destinations remaining largely unchanged. The travel behaviour and health effects could be amplified if changes to land use, future population growth, and employment were included. This should be an area of future research.

- **Publication:** Gunn L, Abdollahyar M, Both A, Jafari A, Pemberton S, Giles-Corti B, Singh D (in preparation). *Measuring the health impacts of the Suburban Rail Loop using an agent- and activity-based model.*

Valuing the healthy liveable city

Creating cities that are healthy and liveable is a global priority, with potential benefits for health and the environment. However, studies examining citywide liveability have identified spatial disparities and inequitable distribution of liveability features such as access to transport, major destinations, and walkability – both within and between cities. These in turn affect housing affordability, health, and economic outcomes, and worsen deprivation.

In general, houses located further from established, amenity-rich areas are more affordable. Consequently, there appears to be a value attributable to the planning and delivery of high-quality, walkable built environments with good access to transit and amenities, and this may affect housing affordability. However, these relationships are complex, and there is not always consensus in the literature on the magnitude or direction of house-price premiums in relation to these features, and no evidence on whether these premiums are consistent across area-level disadvantage.

This lack of consensus highlights issues about housing affordability and equity that relate to the question of 'liveable for whom?'. This is important, because studies repeatedly show that neighbourhoods with access to local amenit encourage walking, cycling and active transport use, which are beneficially associated with a range of cardiometabolic risk factors and improved health.

The relationship between the built environment and house prices is often measured using hedonic pricing, which takes into account not only internal factors such as the size and condition of a dwelling, but also external factors such local facilities and the environment. This is because many aspects of the built environment cannot be easily traded in an open marketplace, and consequently cannot be valued using market prices. However, the hedonic pricing literature exploring the value of the built environment – and specifically walkability – has largely ignored the role of socioeconomic spatial patterning, and instead relies on income as a variable to determine differing residential market segments. Thus, it is unclear whether house-price premiums relating to the built environment – and specifically the walkability of an area – differ between advantaged and disadvantaged areas. In the following section we report on our research on this topic.

Understanding inequities in housing affordability by analysing house prices and walkability features by socioeconomic disadvantage

Hedonic pricing models value features of the built environment relating to walkability and liveability in cities. However, cities are socio-spatially patterned, and few researchers have explored this relationship by socioeconomic disadvantage, highlighting questions about housing affordability, equity and liveability.

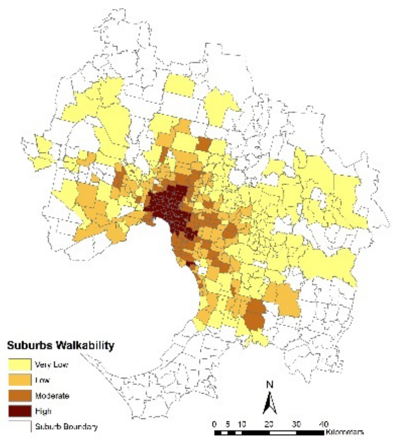
This research aimed to determine whether relationships between walkability and house prices differed according to socioeconomic disadvantage.

We used stratified linear regression models based on quintiles of socioeconomic disadvantage in metropolitan Melbourne, and explanatory built-environment variables: walkability and its components (street connectivity, dwelling density and destination access) and public transit access.

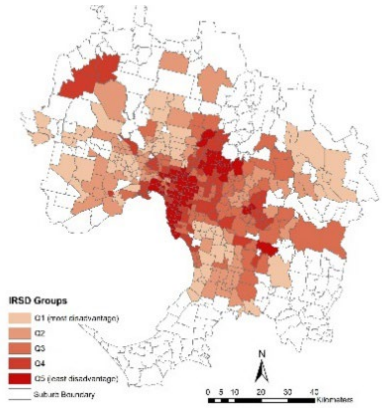
Across socioeconomic strata, destination access increased house prices, while distance from transit access reduced house prices. The association between walkability and house prices was weakest for the most disadvantaged areas, suggesting that houses in disadvantaged areas were more affordable partly because of lack of amenity.

Future planning could redress the relationship between walkability and house prices by making new areas walkable. Increasing densities in outer suburbs would improve access to destinations and transit. However, in established areas inclusionary zoning policies could help give lower-income households access to social and affordable housing in amenity-rich areas, thus reducing built-environment inequities.

- **Publication:** Gunn L, Saghapour S, Giles-Corti B & Turrell G (2022). Exploring inequities in housing affordability through an analysis of house prices and walkability features by socioeconomic disadvantage. Cities and Health, 1–19.
  DOI: 10.1080/23748834.2022.2072058



(a) Walkability by quartile



(b) Disadvantage by quintile

Figure 2. Walkability and socioeconomic disadvantage across Greater Melbourne

Building research capacity

Building the Healthy Liveable Cities Lab team and its capacity have been important aspects of this project. Many of the original researchers have moved into more senior positions in the team or are undertaking higher degrees. We aim to build capacity in benchmarking, monitoring and modelling healthy and sustainable cities. This is demonstrated through the involvement of the members of the research team outlined below.

Carl Higgs

Carl Higgs has a background in spatial epidemiology and statistical computing. Since joining the Healthy Liveable Cities Lab as a data scientist in 2015, he has contributed to numerous publications and led the development of the Urban Liveability Index composite indicator for residential addresses, and the examination of its associations with health-promoting behaviour and cardiovascular health. As described earlier, methods that Carl developed for calculating and visualising spatial indicators of urban liveability using open data have been applied to Australian cities, as well as internationally, including for *The Lancet Global Health* series on Urban Design, Transport and Health. Carl began a PhD in 2020 under the supervision of Professor Billie Giles-Corti, Associate Professor Dhirendra Singh and Dr Sebastian Rodriguez, focusing on applications of open science for characterising urban liveability at scale.

Afshin Jafari

Afshin Jafari is an engineer and computer scientist, who joined our team as a PhD student in 2018, under the supervision of Professor Billie Giles-Corti, Associate Professor Dhirendra Singh, Dr Jonathan Arundel and Dr Claire Boulange. In July 2022, Afshin's PhD was approved, and he is now a research fellow in the Healthy Liveable Cities Lab. His research (summarised earlier) has focused on modelling mobility and cycling. Afshin is currently a collaborator on an NHMRC-UKRI–funded project Joining Impact models of transport to the Built Environment (JIBE), in which he is extending his PhD work by building an integrated model for evaluating 20-minute neighbourhoods.

Dr Alan Both

Dr Alan Both joined the team as part of this project in 2018 and moved to the JIBE project in 2020. Alan is a geospatial scientist whose research is summarised throughout this report. He focuses on spatial data and has created new methods for deriving a virtual population for use in agent- and activity-based models and for evaluating the 30-minute city. On the present project, he has worked closely with Mahsa Abdollahyar and will be one of her PhD supervisors. Alan's current work on the JIBE project focuses on modelling assessments of transport and health impacts.

Mahsa Abdollahyar

Mahsa Abdollahyar is an engineer with training in artificial intelligence methodologies who joined this project in April 2021. She has developed agent- and activity-based modelling methods and applied them to the Suburban Rail Loop as a scenario for establishing how people in Melbourne may respond to the introduction of an orbital cross-city rail line. She recently obtained a scholarship to undertake a PhD in computer science under the supervision of Associate Professor Dhirendra Singh. In her PhD, she will develop a socio-ecological computer simulation model of active travel behaviour. She will combine machine-learning techniques with agent-based modelling to develop a simulation model that will improve decision-making processes for virtual people. This simulation model aims to reflect the complexity of social interactions and social influences and their effects on active travel behaviour.

Translating research into action

The Australian Urban Observatory

The Australian Urban Observatory (auo.org.au) is an online portal for exploring the liveability of Australian cities. It was developed by the Healthy Liveable Cities Lab, with support from the Prevention Centre, the NHMRC CRE-HLC, and the Federal Government's National Environmental Science Program through the CAUL Hub.

To ensure the observatory would serve the needs of stakeholders and collaborators, we held a workshop in August 2018 where participants previewed a prototype observatory and gave feedback on aspects such as design, user interface, features and useability. We incorporated this feedback into the further development of the observatory, leading up to its launch in February 2020.

The Australian Urban Observatory hosts policy-relevant spatial indicators of urban liveability for the 21 cities in the Federal Government's National Cities Performance Framework. Building on the indicators first developed and released in the report *Creating Liveable Cities in Australia*, the indicators disseminated by the Australian Urban Observatory include access to services and amenities, housing affordability, walkability, and overall liveability. The observatory was created to enable policy makers, planners and the wider community to monitor the liveability of Australia's cities over time, to explore spatial inequities, and to evaluate the effect of policies.

The Australian Urban Observatory also disseminates scorecards for each of the 21 cities for which urban liveability indicators are available. Figure 3 shows an example: the report for Sydney. These reports show how each city performs in each of the nine domains of liveability. They include short descriptions for each indicator, and summary statistics – where appropriate – alongside the maps. The maps show the extent of variation for each liveability domain. The maps and summary statistics typically show that liveability is better in the more established inner areas of each of the 21 cities. The reports provide objectively measured evidence that can be used for reporting and advocacy purposes by a broad audience of users, including policy makers and practitioners. The reports are free to download (auo.org.au/measure/scorecards/).

In its first year of operation, the Australian Observatory website received 57,490 visits, and the city scorecards page was accessed 5,815 times. Several local government authorities and government departments have joined the observatory as partners and in 2022 we updated the indicators to enable longitudinal comparisons of liveability over time.

As part of the launch of the scorecards, we disseminated a media release through the RMIT news centre and published an article, '*Understanding liveability and how measuring and valuing it can make it better for everyone*' by Dr Lucy Gunn and Associate Professor Melanie Davern, in *Planning News* 46(4).

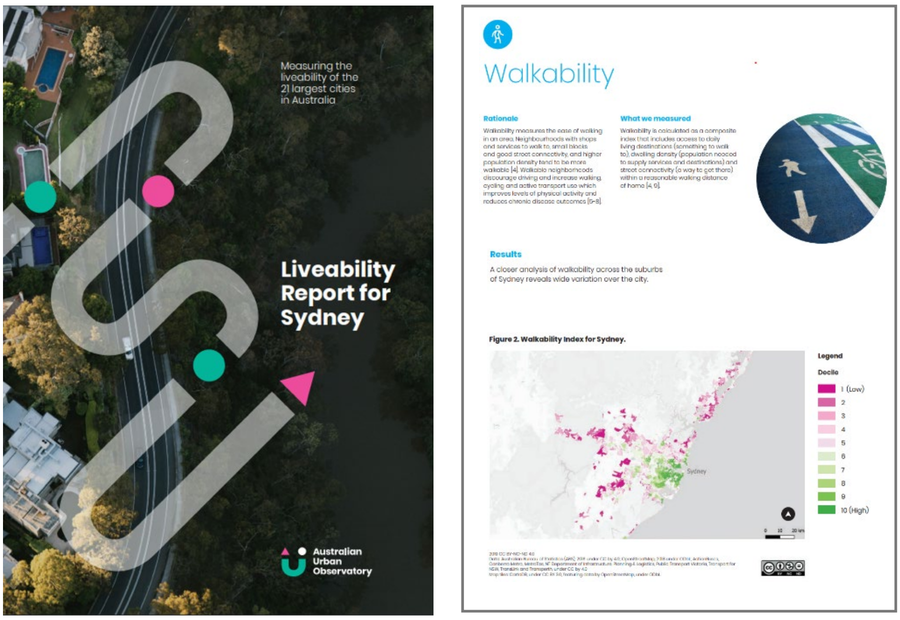


Figure 3. Example cover and page showing indicator information for the liveability domain of walkability for Sydney

The Healthy Liveable Cities Lab team won the Planning Institute of Australia's 2018 Award for Planning Excellence in Victoria for Cutting Edge Research, for its report *Creating Liveable Cities in Australia*, and went on to win the institute's National Award in this category in 2019.

Developing software to track progress towards policy and sustainable development goals: A case study in Bangkok

Tracking progress towards creating equitable, liveable cities has become an important topic for planners and policy makers in various parts of the world. Yet the tasks of managing data, analysing, visualising and reporting on spatial indicators need specialised skills and knowledge. We report on the development of a customisable software framework for calculating and managing spatial urban indicators, using mixed data sources with output reporting in a range of formats including PDF, HTML, map images, statistical plots, geopackage and data tables, for integration into an online indicator portal. The framework was co-designed to support the work of planning and policy experts in Bangkok, Thailand, using a continuous development approach to deliver both the software and the Bangkok liveability indicator outputs concurrently across the course of the project. We demonstrate how flexible project customisation requiring minimal programming experience can enable the software to be applied in diverse cities.

- **Publication:** Higgs C, Alderton A, Davern M, & Badland H (in preparation). *Developing a software framework for tracking progress towards policy and sustainable development goals: A case study for spatial indicators of Bangkok liveability*.

Healthy and Sustainable City Indicators report series: Comparing 25 cities around the world

This collection of brief reports outlines how 25 cities perform on a selection of spatial and policy indicators of health and sustainability, measured as part of *The Lancet Global Health* series on Urban Design, Transport and Health.[28, 40, 42, 43, 45] Our collaborative study examined the spatial distribution of urban design and transport features and the presence and quality of city planning policies that promote health and sustainability in 25 cities across 19 countries. A total of 46 reports were prepared in 16 languages with the assistance of local collaborators. These reports are hosted by the Global Observatory of Healthy and Sustainable Cities www.healthysustainablecities.org/25cities, as well as being available on Figshare.

- **Publication:** Global Healthy and Sustainable City Indicators Collaboration (2022). *Healthy and Sustainable City Indicators report series: Comparisons with 25 cities internationally.* RMIT University. Series. Higgs C, Lowe M, Giles-Corti B (eds). doi.org/10.25439/rmt.c.6012649.v1 and being promoted through the Global Observatory of Healthy and Sustainable Cities www.healthysustainablecities.org/

The Transport Health Assessment Tool for Melbourne (THAT-Melbourne)

THAT-Melbourne (auo.org.au/transport-health-assessment/) is a freely accessible, web-based simulation tool of transport and health, housed in the Australian Urban Observatory (auo.org.au). It was developed as part of a larger research partnership project with the Victorian Department of Transport.

THAT-Melbourne measures the health effects of physical activity achieved by replacing short car trips with walking and cycling for transport. It was built using a quantitative health impact assessment model, and its simple interface allows users to select criteria for a variety of scenarios for walking, cycling, or a combination of both. Each scenario can be tailored to accommodate different trip types, ages and sex of the population, as shown in Figure 4. The tool quantifies health effects in terms of health-adjusted life years, life years, and reductions in chronic disease for a cohort of people across a lifetime.

The tool aims to support knowledge translation, capacity-building and infrastructure planning for active transport in the fields of transport, planning and teaching. For example, the health consequences calculated with the tool provide evidence for planning and teaching purposes and for advocating for infrastructure – such as cycle lanes and footpaths – that encourage healthy and active transport, which can be used in reports and business cases.

THAT-Melbourne was launched via a webinar in April 2021 to an audience of more than 100 people – mostly government and industry policy makers and practitioners. Throughout 2021, RMIT researchers have presented THAT-Melbourne to a broad variety of audiences, including policy makers, practitioners, and students both in Australia and overseas. It has also been presented in an RMIT short course on integrating health and planning, by RMIT Europe in the European Institute of Innovation and Technology and RMIT Europe Urban Mobility series on health and the environment, and in the Massive Online Open Course on liveability and mobility. Lead modeller Dr Belen Zapata-Diomedi has presented on THAT-Melbourne four times, including at the 2021 State of Australian Cities conference in Melbourne, where she was awarded a prize for best presentation by an early-career researcher, under the City Health and Liveability theme.

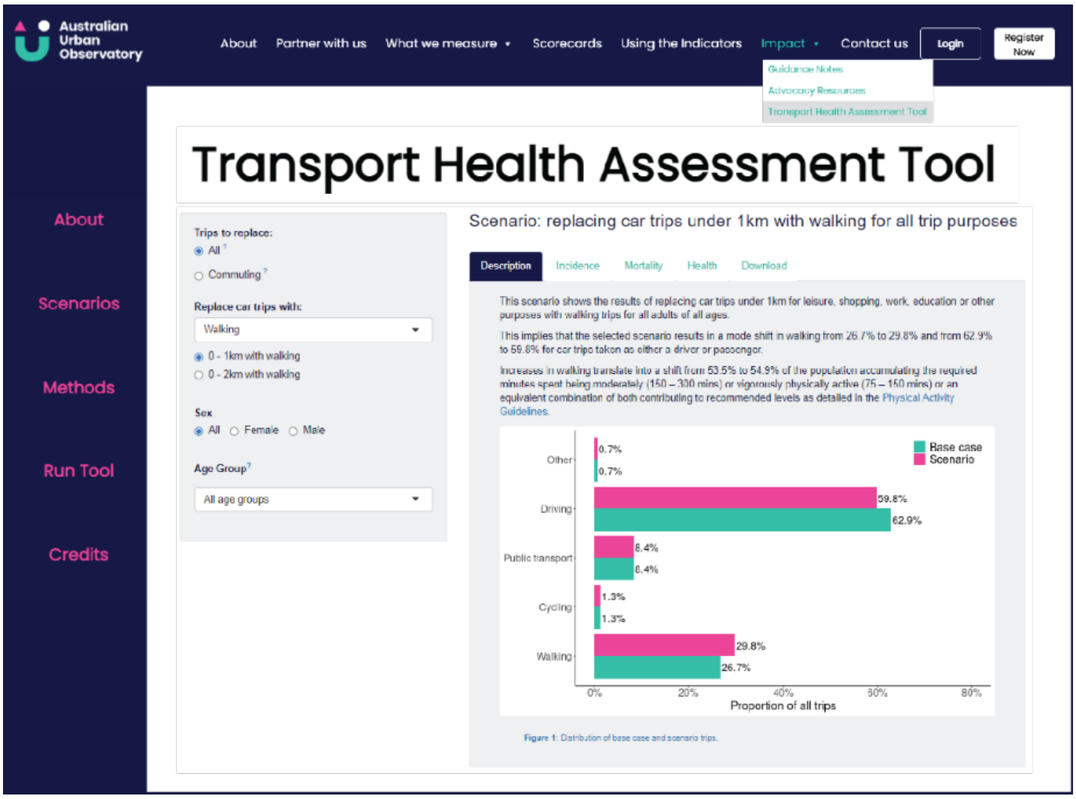


Figure 4. Screenshot showing web access to the Transport Health Assessment Tool for Melbourne

In further promoting the tool, RMIT researchers published an article, '*Helping planners understand health benefits through the Transport Health Assessment Tool for Melbourne (THAT-Melbourne)*', in the Planning Institute of Australia's industry journal *Planning News*.[49]

In supporting the development of scenarios for THAT-Melbourne, a series of interviews with 24 policy makers and practitioners working in the fields of active transport and transport planning were undertaken.. The aim was to learn more about gaps and priorities in citywide active transport infrastructure that could potentially support the development of models by RMIT researchers. This is relevant to many projects, including the Benchmarking, Modelling and Valuing the Healthy Liveable City project (funded by The Prevention Centre) and the JIBE project (discussed previously).

Translating knowledge into action, and building research capacity, were primary aims of the project. THAT-Melbourne allows practitioners to provide additional evidence when advocating for active transport infrastructure which, if built, will have lasting benefits for Australians living in more healthy, sustainable and liveable cities. In 2021, RMIT researchers nominated THAT-Melbourne for a Planning Institute of Australia (PIA) Award for Excellence in Planning Research, in recognition of its potential influence on planning. The PIA Awards recognise excellence in planning in a range of disciplines and sectors, seeking out the best of planning state-wide and nationally. The RMIT research team won the award, and in 2022 went on to win the PIA National Award, presented at that year's PIA National Congress in Hobart.

The THAT-Melbourne project was led by Dr Lucy Gunn and included Dr Belen Zapata-Diomedi (modelling lead), Dr Alan Both, Dr Annette Kroen, Dr Chris De Gruyter, Dr Ali Abbas, Dr Geoff Browne, Ms Mahsa Abdollahyar and Associate Professor Melanie Davern at RMIT University, along with Hugh Batrouney, Dr Morteza Chalak, Anh Nguyen, and Rick Williams from the Victorian Department of Transport.

The research team gratefully acknowledges the funding from RMIT University's Enabling Capability Platform Opportunity Fund for Research and Impact and the support of our project partners from the Victorian Government at the Department of Transport. We also acknowledge the RMIT University Centre for Urban Research, the Urban Futures Enabling Capability Platform, and the Prevention Centre.

Contributing to the Federal Government's National Cities Performance Framework

In 2012, the director of the Federal Government's Major Cities Unit, Dorte Ekelund, agreed to become an industry partner of the NHMRC CRE-HLC, to provide Federal Government insights into the relevance of our team's work on liveability. Following a change of government, this advice was provided by Mr James Collette at the Department of Infrastructure and Regional Development. Under the Turnbull government, the Cities Program was relocated again, to the Department of Prime Minister and Cabinet, with our team's work guided by Kate Lynch before returning to the Department of Infrastructure under the Morrison government.

When the Prevention Centre National Liveability Study was initiated, the Federal Government Department of Infrastructure was an industry partner. It helped shape the project and provided advice on measuring and testing urban liveability indicators. In 2017, an opportunity[50] arose to translate those indicators into policy, when the Federal Government proposed establishing a National Cities Performance Framework[51] of liveability and sustainability performance indicators. Its purpose was to help all levels of government, industry and the community to better target policies to promote safety, social cohesion and human health, and improve the quality of the local environment. Our team made submissions to the department and met with departmental officials to discuss the inclusion of city-wide indicators from our National Liveability Study.

At first, the National Cities Performance Framework included only two of our National Liveability Study indicators: access to public transport and access to public open space. However, in 2019 the (then) Department of Infrastructure, Transport, Regional Development and Communication sought the inclusion of four more indicators to measure access to local amenities supporting healthy lifestyles: public transport with regular daytime weekday service; any public open space; a large public open space of 1.5 ha or larger; or meeting local neighbourhood liveability criteria (walkable neighbourhoods and social infrastructure access). Our team calculated these citywide indicators for all 21 cities in the National Cities Performance Framework.

Overview of presentations

The Healthy Liveable Cities Lab regularly participates in webinars and conferences, and gives presentations to funders, partners and interested organisations on research findings from the project. These knowledge translation activities are an important part of working in partnership with our funders and with organisations and individuals who can apply our research to support evidence-based decision-making.

In addition to research translation activities targeting our industry partners (workshops held in July 2019, September 2020 and November 2020), since 2018 – despite the impacts of the COVID-19 pandemic - members of the Healthy Liveable Cities Lab have delivered at least 35 presentations on the Prevention Centre national liveability project to external groups or at conferences.

Future research

Joining Impact models of transport to the Built Environment (JIBE)

Creating healthy, sustainable, liveable cities is a priority in both Australia and the UK. Growing evidence suggests that how we plan our cities can influence the prevalence of preventable health risks such as physical inactivity, obesity, noise and air pollution, and road trauma.

The JIBE project began in 2020 and brings together Australian and UK urban experts to virtually model and test the benefits of transport planning in creating healthier and sustainable cities, in both countries.

By testing and estimating the health consequences of scenarios in urban and transport planning in different places, we can advise city planners and public health practitioners on which interventions have the greatest chance of promoting good health, and thus guide future planning.

Funded by the UK Research Institute (UKRI) and the Australian NHMRC, the JIBE project brings together research linking the built environment, transport and health behaviour to develop computer models that can better inform urban and transport planning policy and practice in Australia and the UK.

Briefly, the project builds on the research supported by the Prevention Centre in the current project. It is divided into seven work packages:

1. Co-production and policy review to develop built-environment measures and scenarios for England and Australia: Audrey de Nazelle (lead), James Woodcock, Billie Giles-Corti, Lucy Gunn, Belen Zapata-Diomedi, Liton Kammaruzzaan, Rohit Sharma.
2. Developing spatial measures of the built environment for England: Liton Kamruzzaman (lead), Billie Giles-Corti, Jenna Panter, Anna Goodman, Lucy Gunn, SM Labib.
3. Linking built-environment measures to transport behaviours for England: Lucy Gunn (lead), Gavin Turrell, Billie Giles-Corti, Anna Goodman, Jenna Panter, Liton Kamruzzaman, Tayebeh Saghapour, SM Labib.
4. Synthetic population for England matching on built-environment characteristics and including destinations and routes: Dhirendra Singh (lead), Alan Both, Anna Goodman, Lucy Gunn, Corin Staves, Aruna Sivakumar.
5. Upgrading England exposures and health impact model based on improved spatial and travel resolution: James Woodcock (overall lead, physical activity and traffic injuries), Anna Goodman (overall lead and physical activity), Liton Kamruzzaman (green space), Belen Zapata-Diomedi (health modelling), Audrey de Nazelle (air pollution), John Gulliver (noise), Ali Abbas (data science), Billie Giles-Corti (green space), Haneen Khreis (air pollution).
6. Developing METAHIT for Melbourne: James Woodcock (overall lead, physical activity and injuries), Belen Zapata-Diomedi (overall lead and health modelling), Liton Kamruzzaman (green space), Audrey de Nazelle (air pollution), Luke Knibbs (air pollution), Alan Both (data science), John Gulliver (noise).
7. Developing and running scenarios and producing results for England and Melbourne: James Woodcock (lead), Anna Goodman, Audrey de Nazelle, Lucy Gunn, Belen Zapata-Diomedi, Billie Giles-Corti, SM Labib.

The JIBE project is co-led by Professor Billie Giles-Corti and Dr Belen Zapata-Diomedi at RMIT University, and Professor James Woodcock at the University of Cambridge. It involves a multi-disciplinary team of leading researchers with complementary expertise across Australia (Monash University, University of Melbourne, University of Queensland) and England (Imperial College London, London School of Hygiene and Tropical Medicine, University of Leicester). More about the JIBE project is available at https://jibeproject.com/

Publications from this project

Abdollahyar M, Both A, Jafari A, Singh D, Giles-Corti B, & Gunn L (in preparation). Using an agent- and activity-based model to evaluate active transport impacts of a major infrastructure investment in Australia: The Suburban Rail Loop.

Both A, Gunn L, Higgs C, Davern M, Jafari A, Boulange C, & Giles-Corti B (2022). Achieving 'active' 30 minute cities: How feasible is it to reach work within 30 minutes using active transport modes? *ISPRS International Journal of Geo-Information 11*, 58. doi.org/10.3390/ijgi11010058

Both A, Singh D, Jafari A, Giles-Corti B, & Gunn L (under review). An activity-based model of transport demand for Greater Melbourne.

Giles-Corti B, Saghapour T, Turrell G, Gunn L, Both A, Lowe M, Rozek J, Roberts R, Hooper P, Butt A, & Higgs C (under review). Spatial and socioeconomic inequities in liveability in Australia's 21 largest cities: Does city size matter?

Global Healthy and Sustainable City Indicators Collaboration (2022). Healthy and Sustainable City Indicators report series: Comparisons with 25 cities internationally. RMIT University. Series. Higgs C, Lowe M, Giles-Corti B (eds). https://doi.org/10.25439/rmt.c.6012649.v1 and being promoted through the Global Observatory of Healthy and Sustainable Cities www.healthysustainablecities.org/

Gunn L, Saghapour S, Giles-Corti B, & Turrell G (2022). Exploring inequities in housing affordability through an analysis of house prices and walkability features by socioeconomic disadvantage. *Cities and Health*, 1–19. doi.org/10.1080/23748834.2022.2072058

Gunn L, Abdollahyar M, Both A, Jafari A, Pemberton S, Giles-Corti B, Singh D (in preparation). Measuring the health impacts of the Suburban Rail Loop using an agent- and activity-based model.

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Jafari A, Singh D, Both A, Abdollahyar M, Gunn L, Pemberton S, & Giles-Corti B (2021). Activity-based and agent-based Transport model of Melbourne (AToM): An open multi-modal transport simulation model for Greater Melbourne. *arXiv preprint* arXiv:2112.12071.

Jafari A, Singh D, Gunn L, Collins N, Both A, & Giles-Corti B (under review). Using random forest to capture the impact of road and junction attributes on cycling speed for city-scale agent-based simulations.

Jafari A, Singh D, Saghapour, T, Pemberton S, Both, A, Gunn, L, Giles-Corti B. (in preparation). Using agent-based modelling to examine the potential impact of implementing city-wide cycling corridors on cycling for transportation in Melbourne.

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