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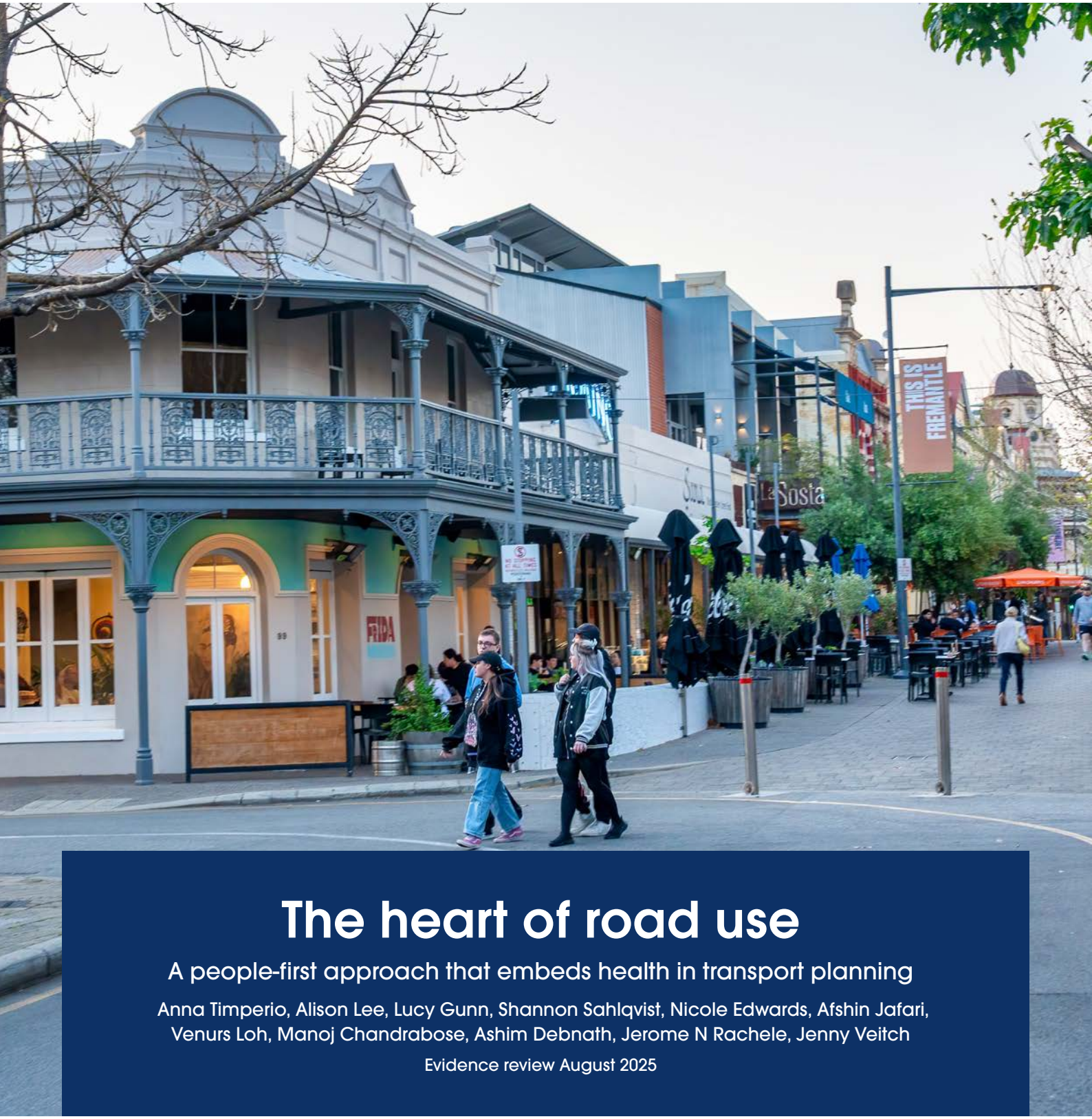

The heart of road use

A people-first approach that embeds health in transport planning

Anna Timperio, Alison Lee, Lucy Gunn, Shannon Sahlqvist, Nicole Edwards, Afshin Jafari, Venurs Loh, Manoj Chandrabose, Ashim Debnath, Jerome N Rachele, Jenny Veitch

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Executive Summary

Putting people first as we plan and re-design our city streets can reduce barriers to active travel and improve heart health. With the national focus on increasing housing supply, new neighbourhoods and residential communities are under construction across the country. There is an opportunity for transport and infrastructure to prioritise the health of residents and visitors, reducing dependence on cars for daily activities.

The way roads are used has changed over time from places for mixed modal transportation and social and economic life to places primarily focused on car-based transport. Streets designed for a mix of uses are now the exception rather than the norm. A growing trend of car dependency in Australia has been influenced by factors such as geography (e.g. regional vs capital cities), household income, urban sprawl, limited access to public transport, and car-focused road infrastructure. Car dependency poses a significant public health challenge due to prolonged periods of time spent sitting, traffic-related air pollution and noise.

Alternatives to car travel, such as active travel that involves walking, wheeling and bike riding, can contribute to improved health outcomes, including reduced risk of heart disease. This review presents evidence to support health being considered as a core factor in street design and for planning decisions that support active travel. Street design elements and considerations identified in this evidence review that have a positive impact on heart health through supporting increased physical activity include speed reduction, traffic calming, presence of footpaths and crossings, network planning/connectivity, streetscape aesthetics and placemaking.

The Heart Foundation recognises the opportunity to improve health and wellbeing for people by prioritising design of streets and neighbourhoods to support active travel. In this paper, recommendations are put forward that can be applied by urban planning practitioners to build community and government support for transport changes that can also improve heart health.

Summary of Recommendations

1. Prioritise people-first approaches to street design and implementation for urban road projects at all levels of government.
2. Provide high-quality infrastructure that supports people walking, which is separate from other forms of micromobility that travel faster than walking speed (e.g. bikes and e-scooters).
3. Establish low-stress bicycle riding networks connecting daily living destinations like public transport, shops and schools. These networks should separate bicycle riding infrastructure from vehicular traffic on busy roads and be designed to accommodate a range of micromobility users.
4. Ensure that road crossings increase overall neighbourhood accessibility by being highly visible, placed in logical, convenient locations that service the area. Timing of traffic signals at road crossings should have short wait times and ensure adequate time to cross streets for people of all levels of mobility.
5. Improve the connectivity of neighbourhoods for people walking, wheeling and bike riding via linear parks, cut-throughs and other measures, intersection density and layouts that support more direct route options.
6. Ensure universal accessibility of local street infrastructure so that it can be used safely by all people, including those with disability or limited mobility, older people and children.
7. Reduce speed limits and volume of vehicular traffic using street-level traffic calming measures or area-wide approaches like Low Traffic Neighbourhoods (LTNs).
8. Create attractive main streets with greenery, lighting, public amenities and outdoor dining that people access by foot or bike.
9. Build community awareness and support for people-first approaches to road use by adopting values-based messaging in public communications that can grow support for walking, wheeling, bike riding and other active transport initiatives.
10. Develop comprehensive neighbourhood-level plans that incorporate the maximum number of recommendations from this report to ensure maximum benefits to people living in, working in and visiting these neighbourhoods.

Definitions/glossary:

Active travel: Defined recently as 'travel in which the sustained physical exertion of the traveller directly contributes to their motion'.[1, p154] This includes modes of travel such as walking, wheeling or riding using a traditional bike or e-bike, skateboarding and kick scootering. Active travel also includes the use of e-mobility devices such as e-bikes even though their use typically requires less physical effort. In this paper we also include wheeling and other micro-mobility devices as these modes often move through pedestrianised environments.[2]

Active travel is primarily used as a verb (action word); and active transport as a noun.

Car dependency: A situation in which urban design, infrastructure, and cultural norms prioritise car use, making alternative modes of travel such as walking, wheeling, bike riding, or public transport less viable or attractive.

Cicloruta: an extensive network of bike paths that connect to public transport and other key destinations.

Ciclovia: Also known as open streets, these are where streets are temporarily closed to vehicular traffic and opened to other forms of movement and social activity including walking, wheeling and bike riding. The first Ciclovia was held in Bogota, Colombia in 1974 and continues to the present day.

Complete streets: A street or roadway that is designed, planned and delivered to provide for, and accommodate, all modes of transport and users including people walking, wheeling, bike riding, using public transport and driving private vehicles.

Cut throughs: Footpaths or other pathways between buildings or properties, not associated with roads, that enable greater route connectivity for people walking, wheeling or bike riding. They can be located at the terminus of cul-de-sacs, and other mid-block locations to increase permeability of people walking, wheeling and bike riding.[3]

Cycling: Travel using a bike, including traditional, recumbent and e-bike as well as any form of trike (a three wheeled bike). Although e-bikes require less physical effort to operate, they are typically considered as a form of physical active travel. The term 'cycling' can be used interchangeably with bike riding.

Low stress bike riding: Describes a bike riding network that provides routes between an origin and destination that do not require bike riders to exceed their personal tolerance for traffic stress, or an undue level of detour to avoid traffic stress.[4]

Micro-mobility: Lightweight, personal travel devices that operate at low speeds (usually <25 km/hr). These can be non-motorised (eg. traditional bicycles, rollerblades or skateboard), electric-assisted (eg. e-bike) or motorised (eg. mobility scooter, electric wheelchair or e-scooter).[1]

Modal filters: A street design strategy that limits cars while allowing other modes, such as people walking, wheeling or riding bikes, to pass through. Modal filters create an accessible network of low traffic streets for walking, wheeling and bike riding.[5] They can also be known as filtered permeability. Approaches typically employ physical structures such as bollards, planting or street furniture, but can also include signage and CCTV enforced modal filters.

Multi modal streets: Streets that provide for, and integrate, a range of different types of transport.

Pedestrianised environments: An area within a built environment which focuses on people and often restricts accessibility and movement by cars and other motorised forms of transport including buses.

People-first approach: An approach to traffic engineering, transport planning and road design that prioritises community health and wellbeing. This is achieved through the creation of safe, convenient and connected transport options for all people, including those who are walking, wheeling, bike riding, using public transport and driving cars.

Physical activity: 'Any bodily movement produced by skeletal muscles that requires energy expenditure',[6, p126] including activities such as walking, wheeling, bike riding and recreational exercise. Physical activity can be categorised into different domains: transport, leisure, occupational and household.

Public transport: Shared transport services for the general public including buses, trains, trams, light rail and ferries.

Quietway: Low volume streets where people riding bikes and driving cars are equal road users in a mixed traffic on-road environment.[7] These are typically local streets with low traffic speeds, visual cues and design elements that encourage slower driving and discourage overtaking.[7] Also known as Safe Active Streets in Western Australia.

Road space allocation: The process of determining how road space is distributed among different users and modes of transport, including people walking, wheeling, bike riding, using public transport and driving.

Sedentary behaviour: Activities conducted during waking hours while seated, reclining or lying down that require low levels of energy expenditure.[8] Distinct from sleep. Prolonged sitting in a car (e.g., driving) is a common form of sedentary behaviour.

Street connectivity: The degree to which street networks interconnect based on their arrangement in an area. Typically measured by the density of street intersections. Street connectivity generally enables more direct route choices.

Streetscape: This is the term given to the overall character of a road or street, considering all aspects of its appearance – buildings, roadways, greenery, landscaping, footpaths and other amenity.

Traffic calming: The combination of predominantly physical measures to limit negative impacts from cars, change driver behavior, and improve conditions for other users of streets, such as people walking or riding bikes.[9] Objectives include slowing speeds, improving safety (including perceptions of safety for those on foot or bike), enhancing the street environment and increasing access for a range of transport modes.

Urban heat islands: Phenomenon where urban areas are warmer than surrounding areas due to greater trapping and absorption of heat from the presence of roads, pathways, buildings and dark roofs, as opposed to green and blue surfaces such as parks and rivers.[10]

Walking: Moving by foot. Can include use of walking frames, support animals and other aids.

Wheeling: The action of moving as a pedestrian or walking pace, using manual or self-assisted modes of transport including the use of wheelchairs, mobility aids, scooters and others.

Contents

1. Introduction

1.1 History of road use

Australia has become a car-dependent society. This is not good for our heart health as it can decrease our physical activity and increase air and noise pollution.

Before cars became popular in the early 1900s, urban roads were primarily used for mixed modes of transportation, including walking, bike riding, horse-drawn carriages, and trams, as well as social and economic interactions. Roads facilitated commercial activity by allowing the movement of goods via horse-drawn carts and facilitating small-scale trade, while also providing a shared space for people walking, wheeling, riding bikes and for community life.[11] On-road public transport, such as trams, played a key role in urban mobility, connecting residential areas to commercial and industrial centres.[12]

During the 20th century, cars emerged as the dominant mode of transportation[13] and road design began to prioritise and reallocate space to cars. As part of these global shifts, urban planning and suburban development responded with car-oriented, sprawling cities. Largely driven by the desire to support economic growth and productivity, this car-centric approach began to overlook other forms of on-road transport, like walking, wheeling and bike riding.[11,14-16] Over time, car ownership became essential for travelling large distances and accessing key services and destinations,[17] contributing to a largely car-dependent society (Figure 1), physical inactivity, congestion and pollution.[14-16]

Swanston Street, Melbourne, looking north from beyond Flinders Street, showing cable cars, people, cars and horse drawn vehicles; ca 1910-1920; Image credit: Fowler, Lyle, State Library Victoria, www.slv.vic.gov.au

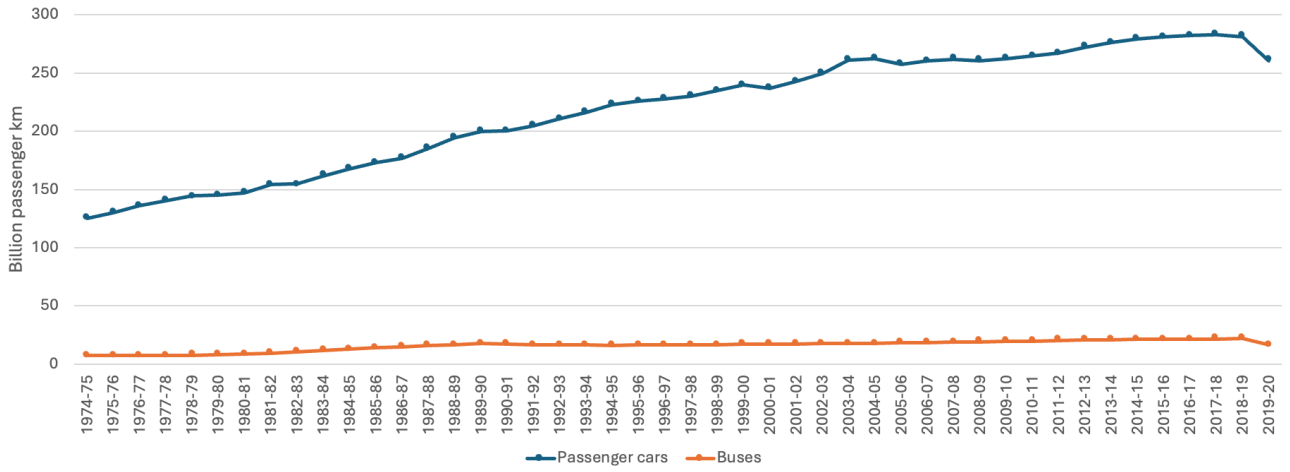

Figure 1: Total national passenger road travel in Australia, bu bus and car 1974-2020. A drop in passenger car and bus transport in 2019-20 is likely attributed to COVID-19. Source: Bureau of Infrastructure and Transport Research Economics (BITRE) estimates presented in the Australian Infrastructure and Transport Statistics: Passengers - Yearbook 2022[18]

1.2 Car dependency in Australia

Car dependency differs with factors such as people's income and location, with higher dependence in low density, outer urban areas.

Car ownership in Australia is among the highest in OECD countries[19] and many parts of Australia are highly car-dependent. In several Australian cities or regions, more than 70% of trips are made by private vehicles, with relatively low use of public transport, walking, bike riding and other modes.[20-24] Reliance on cars for commuting varies across cities and regional/metropolitan areas, with workers in non-capital cities generally having far greater car dependence for work than capital city workers (Figure 2).[25] Car dependency is influenced by a range of factors, disproportionately affecting people living on lower incomes, and in low density, outer urban and peri-urban areas where there is more likely to be poor access to public transport.[17,26-30]

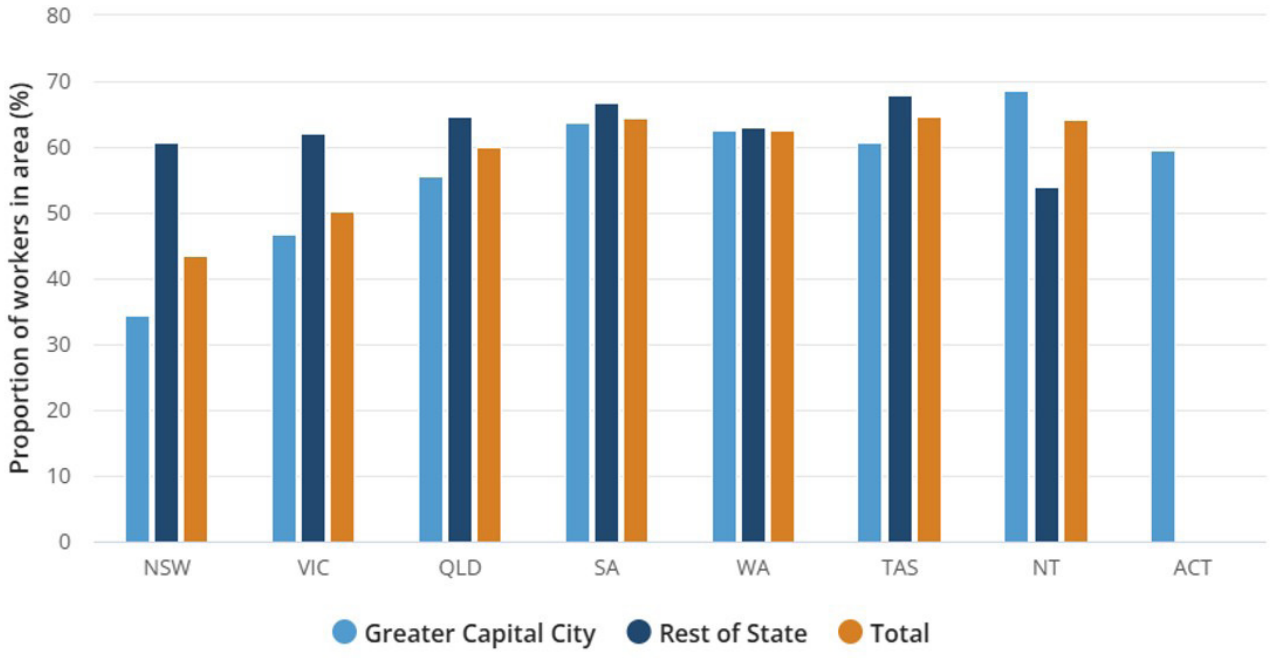

Figure 2: Journey to work – proportion of drivers* in Greater Capital Cities and Rest of State areas, Australia, 2021
**Employed persons aged 15 years or over*
Source: Based on Australian Bureau of Statistics, 2022[25] / CC BY 4.0

1.3 Car dependency and heart health

Traveling by car is a form of sedentary behaviour, and can increase the risk of chronic diseases such as cardiovascular disease.

Car dependency poses a significant public health challenge, with car travel regarded as a pervasive form of sedentary behaviour.[31] There is strong evidence linking longer durations of car use to greater risk of obesity among adults.[32] There is also evidence that prolonged time spent sitting in cars, including as a passenger, is related to a greater risk of diabetes,[33] an unfavourable cardiometabolic risk profile,[33] cardiovascular disease mortality[34] and poor mental health and well-being.[35]

Car dependency can negatively impact health by increasing traffic-related air pollution, which in turn raises the risk of cardiovascular and respiratory diseases[36] via pathways involving oxidative stress, inflammation, changes to the nervous system and vascular dysfunction.[37] Traffic noise can also be harmful to heart health and is associated with an increased risk of ischaemic heart diseases[38] and stroke,[39] likely due to stress responses and disruptions to sleep and circadian rhythms.[38,39]

1.4 Alternatives to car travel are good for heart health

Physical activity, even in small amounts, can lower the risk of heart and vascular diseases. Swapping short car trips for walking, wheeling or bike riding can lead to significant health benefits throughout life.

Active travel has been defined as 'travel in which the sustained physical exertion of the traveler directly contributes to their motion'.[1] Active travel modes such as walking, riding a bike and other wheeled modes, like rollerblading, skateboarding or scooting, are good for heart health – in large part because they involve physical activity. Evidence of the protective effects of physical activity on heart health is strong – even small amounts of physical activity can lower the risk of coronary heart disease, ischaemic stroke and heart failure, and dying from cardiovascular disease.[40]

Physical activity enhances cardiometabolic health, including cardiovascular fitness and blood pressure regulation, and reduces the risk of type 2 diabetes. It also helps maintain a healthy weight in both adults and children[41-43] and is linked to a lower risk of some cancers.[43] Physical activity and exercise is also widely used to treat and manage a range of conditions.[44] Simulations show that swapping short car trips of less than 2 km with walking and car trips of 2-5 km with bike riding could accrue significant health benefits over the lifecourse.[45] Comparative risk assessments and cost-benefit analyses consistently show that the health benefits of switching to walking or bike riding for travel outweigh the risks of injury or exposure to air pollution.[46]

Walking is one of the most popular and accessible forms of physical activity.
Image credit: National Heart Foundation of Australia, Cameron Murray Photography

Walking and bike riding can be undertaken for leisure or recreation purposes, as well as to travel between locations.[1,47] **Walking** is one of the most popular and accessible forms of physical activity that most people are capable of undertaking and requires few resources.[47] For children, walking to/from school can be a significant source of physical activity.[48-50] In adults, taking more steps per day is associated with progressively lower risk of fatal and non-fatal cardiovascular events,[51] particularly among older adults.[51]

Walking, wheeling, bike riding and using public transport are better alternatives for heart health than taking the car.

Evidence suggests that people who **ride a bike** to work or school have higher fitness levels.[50,52,53] Studies that follow participants over time also show that those who ride a bike for recreation or transport have a lower risk of developing cardiovascular disease,[52] and those who ride to work have a lower risk of dying from any cause over the period being studied compared to those who use passive sedentary modes of travel.[52] Riding electrically-assisted bikes (e-bikes) can be good for the heart. While e-bikes require less physical exertion than conventional bike riding, the intensity of physical activity from riding e-bikes can be similar to and sometimes even greater than walking, particularly when riding uphill.[54,55] E-bikes may be particularly helpful for improving cardiorespiratory fitness among people who are not very active and would benefit the most from additional physical activity.[54]

Public transport use can also be good for the heart, as it usually involves active travel at one or both ends of the journey. A study in Tasmania, for example, showed that adults took more steps and accumulated more physical activity on days they travelled by bus compared to days they did not.[56] Switching from car to public transport use can add between 8 to 33 extra minutes of walking per day[57] and is associated with a lower body mass index.[58]

1.5 Other benefits of alternatives to car travel

1.5.1 Environment

Choosing alternatives to car travel can promote positive physical and mental health and can be better for the environment and the economy.

The transport sector, which includes travel in private vehicles, is a significant contributor to greenhouse gas emissions in Australia.[59] Car travel generates heat from exhaust systems, contributing to heat island effects,[60,61] and traffic-related air pollutants react with heat and sunlight to generate additional ozone.[61] Shifting journeys from private car to active travel and public transport are widely promoted to help to reduce CO^2 emissions, protect planetary health and help meet the United Nations sustainable development goals (SDGs), such as 'Ensure healthy lives and promote wellbeing for all at all ages' (SDG 3) and 'Make cities and human settlements inclusive, safe, resilient and sustainable' (SDG 11).[59,62-64] Although low-carbon mobility options like electric cars are becoming more popular and can help reduce traffic-related air pollution, they do not mitigate the negative health impacts of prolonged sitting or road injury.[65]

1.5.2 Economic

Increasing physical activity across the population and reducing reliance on car use can help reduce the economic burden. It is estimated that US$27 billion will be spent per annum globally on new cases of preventable noncommunicable diseases due to physical inactivity by 2030 if levels of physical activity remain the same.[44] The avoidable social cost of traffic congestion across eight metropolitan areas in Australia in the 2015 financial year alone was estimated to be more than

Walking, wheeling and bike riding for young people can create positive social interactions, including with family

Image credit: iStock.com, shapecharge

$15 billion.[13] More walking, wheeling and bike riding can also help to stimulate local economies. People riding bikes have been shown to shop locally and more frequently compared to those who travel by car, and for some types of businesses (excluding grocery stores), people walking and bike riding and public transport users, spend more per trip.[66,67]

1.5.3 Mental health and quality of life

Physical activity is associated with a reduced risk of developing depression, and regular physical activity can reduce general feelings of anxiety.[43] In young people, walking, wheeling (including using a wheelchair) and bike riding can create positive social interactions with peers, family and/or the community, promoting social connection and better social well-being.[68,69] Some studies suggest that children and parents who engage in active school travel may have more positive emotions[70] and feel happier on the journey.[71,72] Relatedly, children and adolescents who usually engage in active travel report better mental health outcomes, including fewer depressive symptoms[73] and higher levels of happiness.[74] In older adults, use of public transport has been linked to better mental health, less loneliness and more regular contact with family and friends.[75]

1.6 Why are roads important for heart health?

People-first street design can enable active, healthy and sustainable travel instead of taking the car.

Supporting heart health starts with better design. Reducing car use and encouraging walking, wheeling, bike riding and use of public transport improves heart health, wellbeing, the economy and the environment. Road and street designs play a key role in enabling active, healthy lifestyles.

There is increasing recognition across transport and land use professionals in Australia of the nuanced role played by streets. Roads and streets are public spaces, contributing to liveability and supporting a diversity of activities and functions, including recreation and play, socialising, growing food, dining and other businesses, as well as supporting active travel.[76]

Streets that are vibrant, where people feel safe, welcome and comfortable to walk, wheel or ride a bike, and that enable them to reach their destinations efficiently and in a heart-healthy way, are places for people.[77] Seeing people actively using streets can also inspire others to do the same, improve perceptions of safety and create opportunities for social interactions. A people-first approach to the use of road space and design of streets is critical for generating shifts from car use to active, sustainable travel and for supporting healthy people and neighbourhoods.

2. Streets that prioritise health

The following section outlines evidence linking aspects of street design to walking, wheeling, bike riding and public transport use, and to heart health.

2.1 Speed reduction

Australia's residential speed limit is amongst the highest in the OECD. Lowering this speed limit to 30 km/h may reduce barriers to people walking, wheeling and bike riding, especially by children.

Fast moving vehicular traffic is a barrier to walking, wheeling and bike riding,[78] and raises safety concerns.[79] As advocated by the World Health Organization,[80] a growing number of cities across the world are reducing speed limits on many streets to 30 km/h (or 20 mph), particularly in residential and built-up urban areas. Examples include Paris, Brussels, Madrid and Amsterdam in Europe,[81] throughout Wales[82] and Bristol[83] in the UK; and the City of Yarra in Australia.[84] However, Australia has one of the highest default speed limits amongst the OECD countries, at 50 km/h on local residential streets in most states and territories.[85] Speed is a particularly important barrier to children's use of streets for play and travel. A review of 16 studies found that lower speed limits or perceived speed of vehicular traffic, or more measures that calm vehicular traffic (e.g. speed bumps), were associated with higher levels of physical activity or active travel in children and youth.[86]

As well as reducing the risk and severity of road trauma,[79,87] lowering speed limits can reduce traffic-related noise. A review of studies conducted in 40 cities in Europe showed that, on average, reducing the speed limit to 30 km/h resulted in a 2.5 dB reduction in noise.[87] This is important as health impact assessments estimate reductions in traffic-related noise from speed reduction will lead to health benefits, including reductions in death and hospital admissions from cardiovascular disease.[88] The effect of road traffic noise pollution on health and wellbeing is increasingly being acknowledged, including its impact on ischemic heart disease.[88]

Lower speed may improve levels of physical activity and active travel, particularly in children.
Image credit: iStock.com, Fotofantastika

2.2 Footpaths for walking and wheeling

Lack of footpaths and walkways can make it difficult for people to choose walking and wheeling.

A walk-friendly environment requires safe and effective walking infrastructure, with footpaths playing a vital role. The presence and quality of footpaths have been associated with more physical activity or walking for transport among children,[89,90] adults[91-93] and older adults.[94] Older adults living in neighbourhoods with no or poorly maintained footpaths report lower levels of neighbourhood participation,[95-97] while poor footpath conditions contribute to an increased risk of falls[98] and fear of falls[99] in middle-aged and older adults.

In some cities and urban areas, footpaths are either absent or not compliant with the recommended widths, making it difficult for people to walk and use mobility aids.[100,101] Safe and effective walking infrastructure includes the provision of a network of high-quality, well-maintained footpaths on both sides of the road. Footpaths should be free from obstructions and can be used by a broad range of people including children, older people, and those with disability or mobility issues requiring aids like walking frames, sticks, scooters or support animals.[96,102-104] Footpath obstructions are related to less frequent outdoor play among children[105] and hinder walking.[101] Separate infrastructure for people walking or using wheelchairs from those using other modes of transport, such as bikes, scooters or other forms of micromobility, may further enhance safety and usability.[106,107]

2.3 Safe bike riding infrastructure

Better design of bike infrastructure such as well-connected cycleway networks and bike lanes which are separated from car traffic can lead to increases in bike riding. Improved infrastructure can address common concerns about safety and create a lower-stress, more convenient way to travel.

Bike riding infrastructure is integral to support shifts from driving to bike riding and other forms of micromobility.[108] Reviews have shown that access to bike lanes is associated with higher levels of physical activity among children[109] and adults.[110] Some studies have shown that implementing bike riding infrastructure – such as pop-up bike lanes, protected bike lanes, expanded bike riding routes that improve connectivity – can increase bike riding.[111-113] Key barriers to bike riding include not wanting to ride in mixed traffic environments and the associated fear of collisions with motor vehicles.[114] Riding on the road with motorised traffic was noted as a deterrent for bike riding by one in two people. A recent study in Victoria classified 78% of adults surveyed as 'interested but concerned' about bike riding, only feeling comfortable doing so in lanes protected from motorised traffic.[115] While safety can be achieved by a range of measures,[116-121] evidence shows that people – particularly women – prefer physical separation from cars.[122]

In many places in Europe, a combination of separated bike riding facilities on streets with heavier vehicular traffic and intersections, alongside extensive traffic calming measures in other areas (like quietways), integration with public transport and cyclist rights of way, helps make riding a bike safer and more convenient.[123] Well-connected bike infrastructure and networks can also play a key role in creating a 'low stress' bike riding environment.[124]

Box 1: Temporary 'pop-up' bike lanes

Cities across Europe,[125] North America[126] and Australia[127] have seen boosts in bike riding after accelerating their cycling infrastructure programs during the COVID-19 pandemic. Flexible, low-cost options like temporary pop-up bike lanes enable biking infrastructure to be installed quickly. In Sydney, the implementation of pop-up bike lanes during COVID-19 substantially increased bike riding, with growth in less than a year ranging from 30% to 500% across different areas in the city.[127] In the US, a temporary pop-up bike lane had a traffic calming effect.[128]

2.4 Road crossings

Safe crossings in convenient places and logical positions can encourage more walking. wheeling and bike riding.

The design and placement of crossings are important factors that contribute to the safety of people who walk, ride or use other wheeled modes of transport.[129,130] In car-centric countries like Australia, research shows that children are less likely to walk or ride a bike if there is a (real or perceived) lack of crossings or safe places to cross roads,[131,132] or if they have to cross busy roads to get to school.[131,133] Among older adults, more positive perceptions of traffic safety is associated with higher levels of physical activity.[91] In addition, more positive perceptions of traffic safety and objectively-assessed traffic or pedestrian safety have been linked to higher levels of physical activity and active travel, respectively.[92]

Older people often express concerns about road crossing safety, including insufficient time to cross roads and long distances between safe crossings points.[96,97,134] Crossings are more likely to be used by people who are walking[135,136] and riding bikes[137] when they are located at convenient places, particularly in relation to the trip origin and destination. Convenient placement, visibility and accessibility (e.g. by people using wheelchairs or people with visual impairments) are essential design features of safe road crossings. Adequate crossing time is also critical, particularly for older adults[138] and people with disabilities, especially on wider roads.

Crossings are more likely to be used when located in convenient places.
Image credit: iStock.com, rudi_suardi

2.5 Connectivity and movement networks

Well connected street, walking and biking networks, combined with measures to calm traffic, could encourage more people to walk, wheel and ride bikes for transport or recreation.

Street connectivity refers to how streets are arranged in an area.[139] A well-connected street network typically features a grid-like layout with a high number of intersections, enabling more direct routes. In contrast, areas with low street connectivity, which often have more cul-de-sacs and fewer intersections, result in longer and less direct travel routes.

In Australia, most inner suburbs near central business districts (CBDs) have main street connectivity but this tends to decrease as distances from the CBD increase.[140] An international study of 14 diverse cities identified a threshold of 98 intersections/km^2 as associated with 80% probability of engaging in any walking for transport-related purposes, and 122 intersections/km^2 as associated with 58% probability of achieving 150 mins/week of any walking.[141] However, only 13% of residents in Adelaide and Sydney and 21% in Melbourne live in neighbourhoods that meet a threshold of 122 intersections/km^2.[142]

There is consistent evidence, including from Australia, that main street connectivity can encourage walking[143] and riding a bike[110] for transport, and walking for recreation.[144] Since bikes can cover longer distances than walking, maintaining route connectivity over long distances is particularly important for encouraging bike riding.[145] Street connectivity is also a key component of the 'walkability index' alongside residential density and mixed land use. Together, these factors are associated with higher levels of physical activity across all ages, improved cardiometabolic risk factors (e.g. lower waist circumference and blood pressure)[146] and better physical functioning.[147]

However, grid-like street patterns may generate additional through-traffic on residential streets,[148] highlighting the importance of measures that filter and calm traffic (see Box 2). Linear parks and walking and bike paths can help improve connectivity for people on foot or bike in areas with low street connectivity.[139]

Box 2: Cicloruta

The Cicloruta in Bogota, Columbia, is an example of a large network of bike paths that connect to public transport and other key destinations – 70% of users of the network achieve the recommended amount of physical activity for health from biking for transport alone.[149]

2.6 Modal filters

Modal filters can be a low cost and effective way to redirect and calm traffic by filtering out certain vehicles or travel modes. They can take varied forms, from utilitarian temporary concrete barriers to stop motorised vehicles travelling, through to attractive plantings (see Figure 3). In areas that don't have separated footpaths and/or bike riding facilities, modal filters can reduce through-traffic and lower speeds of motorised vehicles without impacting access by foot, bike or other wheeled modes, resulting in safer and more pleasant movement networks for people walking, wheeling, or riding a bike.

Modal filters have been suggested to be one of the best types of infrastructure to encourage active transport and discourage car use.[5] A small exploratory study in the UK, for example, found increases in walking and bike riding volumes on a residential street where through-traffic was restricted using modal filtering.[150]

Modal filter in Richmond, Melbourne

Modal filter in Redfern, Sydney

Figure 3: Two modal filters - low cost (LHS) and high cost (RHS).

Image Source: LHS Institute for Sensible Transport, 2024 (used with permission), RHS Alison Lee, 2024

2.7 Streetscape aesthetics and amenities

Greenery, park benches and street lighting can encourage more people to walk.

Street trees,[151,152] eye-level greenery,[151,152] and lighting[153] are associated with higher levels of walking and bike riding, providing pleasant, safe and clearly visible spaces for moving around. Trees provide shade, shelter and aesthetic appeal, improving the overall quality of the environment and encouraging walking, wheeling and bike riding.[78,154] Lighting facilitates safety for people walking at night, particularly for women and older people.[153,155,156] Aesthetically-pleasing scenery, including greenery, is associated with more walking among older adults.[91]

To encourage walking, environments should include seating or benches for people to rest during their journey and while waiting for public transport.[96] High-quality seating can also act as a place for people to meet and spend time socialising outdoors.[157]

2.8 Placemaking

Through a multidisciplinary approach to designing public spaces, placemaking aims to create vibrant, inclusive, and meaningful places that meet community needs.

Kerbside amenities, street-based events and attractive streetscapes not only encourage active travel, but can also generate more revenue for local businesses.

2.8.1 Main Streets that balance movement/parking with places

In 'main street' environments (e.g. shopping areas), there is growing recognition of the role of creating beautiful, welcoming spaces to attract more people, and motivate them to shop in-person and support local businesses instead of shopping online.[158] Using road space more efficiently and in a way that attracts more people to walk, wheel and ride a bike may help achieve this. An Australian study showed that replacing a car parking space with bike parking or a dining parklet can generate about 80% more spending for businesses, compared to when the space was available to an average of 1.2 people as car parking.[159]

The Streets as Shared Spaces program in NSW aimed to trial ideas that rethink streets as safe, shared public places, including parklets, cycleways, slower speed limits, street closures, greening, new crossings, lighting, public art, widened footpaths, and community activations and events. An evaluation showed that such changes can generate an estimated 22% more revenue for businesses largely through the ability to attract more people from a local catchment area when streetscape aesthetics are prioritised through people-centred design.[159] Kerbside amenities, such as bike parking and parklets, help make high streets more attractive and enhance the viability of local shopping strips by improving the quality of the public space.

Improving the quality of public space can make main streets more attractive, enhancing the viability of local shops.

Image credit: iStock.com, Jennifer Watson

2.8.2 Open Streets

Open Streets include temporary initiatives usually in the form of an event, market or street party, where streets are closed to motorised traffic through a barrier and opened for people to walk, wheel and ride bikes. In NSW, the Open Streets program that temporarily closed streets and laneways to cars for community events and activations between December 2021 and May 2022, attracted high numbers of visitors (370% increase during the event period), and generated an average estimated increase of 100% in sales turnover for local businesses.[160]

Internationally, initiatives similar to Ciclovia that close streets to cars on specific days to open up the space for people to enjoy leisure activities, such as walking, wheeling and bike riding, have expanded across the world over the past few decades.[161] The world's first Ciclovia is said to be that of Bogota, Colombia, which commenced in 1974. The Bogota Ciclovia now operates every Sunday and on public holidays. In Bogota, regular participation in Ciclovia is linked to higher levels of physical activity compared to infrequent use,[149] and living close to a Ciclovia or having more Ciclovia lanes close to home is associated with higher odds of using the Ciclovia among adults[162] and more physical activity among older adults.[163]

Opening streets to people can attract visitors.
Image credit: iStock.com, Jennifer Watson

2.8.3 Play Streets

Play Streets are a type of Open Streets initiative focused specifically on play. Play Streets, where a neighborhood street is temporarily closed to vehicular traffic, provide opportunities for residents, particularly children, to play and socialise. They can reduce inequities in underserved or under-resourced communities where there is limited access to quality play and recreation spaces. Play Streets can be re-occurring or episodic and typically include the provision of equipment to promote active play. Evidence suggests that Play Streets encourage children to play more outside, increase their physical activity and reduce screen time.[164] Play Streets have also been documented to strengthen relationships with neighbours and improve social interaction for children[165] and adults.[164]

2.8.4 Complete Streets

The Complete Streets approach to street planning and design allocates space to all road users, including people walking, wheeling, bike riding, using public transport or travelling in cars. It prioritises active and public transport modes while ensuring the safety and comfort of all users.[166] This equitable approach considers the needs of people of all ages, abilities and circumstances.[166]

In the US, increases in walking, bike riding and public transport use,[167,168] as well as active travel to and from public transport[168] have been observed after implementation of Complete Street projects. Evaluations also show improvements in safety, with reductions in collisions and injury estimated to saved USD18.1 million in the first year alone.[167] Additionally, there is some evidence of economic benefits, with increases in employment, new businesses, property values and investment from the private sector after Complete Streets projects were installed.[167]

2.9 Area-wide traffic calming and road reallocation approaches

Area-wide approaches like Low Traffic Neighbourhoods and Superblocks could mitigate a range of barriers to walking, wheeling and bike riding.

2.9.1 Low Traffic Neighbourhoods

Low Traffic Neighbourhoods (LTNs) are designated areas where measures such as modal filters are implemented to discourage through-traffic of vehicles, while allowing access for people walking, wheeling and bike riding. Increasingly implemented throughout the UK, LTNs aim to encourage drivers to use main roads rather than cutting through residential areas, in part to reduce traffic-related noise and air pollution, and risk of accidents, as well as to lower vehicular traffic volumes. Streets can be closed to vehicular traffic in one or both directions, either all day or only during specific times.

A comprehensive evaluation was undertaken of LTNs in three outer London boroughs where modal filtering was coupled with the provision of bike lanes and bike storage facilities and upgrades to walking paths. The evaluation showed increases in active travel after one[169] and five years[170] among those living close enough to the changed areas to expect travel behaviour to be affected ('high dose' areas) compared to those living further away ('low dose' areas). Relative to a comparison area, residents held more favourable views of the local area for bike riding (but not walking) after one year.[169] Evaluations show a range of additional benefits of LTNs, including a reduction in car/van ownership,[171] less street crime[172] and fewer road traffic injuries.[173] Importantly, no increases in emergency response times were observed on streets with modal filters or on boundary roads.[174] In an inner-city borough of London with low car ownership, traffic speed decreased in each and volume decreased in two of three neighbourhoods one year after a LTN was introduced, but no changes in walking or bike riding were observed, relative to a comparison areas, possibly due to already high levels of walking and bike riding.[175]

2.9.2 Superblocks

Barcelona's 'Superblock' model[176,177] aims to reclaim public space for people and to promote sustainable mobility and active lifestyles. Within each Superblock (400m x 400m), roads are re-prioritised for walking and bike riding, space for cars is reduced and local traffic speed limits are limited to 20 km/h. Some interior streets are pedestrianised or transformed into public squares or parks, with an emphasis on creating and enhancing green space and green corridors to reduce the urban heat island effect and mitigate climate change.

Bounding roads (arterials) handle through traffic for motorised vehicles with speed limits of up to 50 km/h, while also providing dedicated space for people walking and wheeling, for bike riders and for buses, with bus stops placed every 400 m.

Evaluations of superblocks show some improvements in noise and air quality (reduced nitrogen dioxide, NO^2), as well as well-being and socialisation benefits.[177] However, to date few studies have explored changes in physical activity, walking or bike riding in Superblocks.[177,178] Modelling as part of health impact assessments indicate that implementation of the 503 planned Barcelona Superblocks[177] could save 667 premature deaths through a combination of increased active travel and use of public transport, reduced air pollution and traffic-related noise and heat, and increased exposure to green space, resulting in annual health savings of 1.7 billion EUR.[176]

BOX 3: Te Ara Mua – Future Streets

New Zealand's Te Ara Mua – Future Streets followed a community participatory design approach to upgrade streets and enhance public places. This involved a comprehensive upgrade to the street network including raised table zebra crossings, protected bike lanes (which created narrower vehicle carriageways), wider footpaths with improved lighting, lighting in parks that experienced antisocial behaviour, coloured and tactile intersection treatments, and adding plants to traffic islands. The type of treatment varied depending on whether the road was an arterial or collector road or a lower category street. The improvements made incorporated elements that reflected the identity of the Mangere people such as endemic plants and pathway colours that referenced shark oil, a substance traditionally used by the Māori people.[179]

Evaluations showed decreases in traffic speed and volumes on smaller streets, and speed on collector and arterial roads relative to control sites.[180] Based on video analysis, streetscape changes at one site made crossing roads easier, quicker and safer for people on foot or using mobility aids, with fewer near misses with vehicles.[181] In addition, there were improvements in perceived neighbourhood safety (security, safety from crime) among residents, though findings for perceived traffic safety were mixed.[182]

3. Promoting positive change

3.1 Community support for change

There is emerging evidence of community support for streets that better accommodate walking, wheeling and bike riding. In 2024, a national poll of more than 1,000 people living in Australia found that three in four respondents supported adding more footpaths and cycleways in their local area.[183] Another survey of more than 3000 people living in Australia conducted in 2025 found that 93% valued being able to be active in their local area, with more than half (53%) considering it very important to them.[184]

People-first principles applied to the allocation of road use have been shown to be important considerations when people are deciding where they would like to live. As shown in Figure 4, when prompted, 94% of people surveyed considered that living within easy walking distance of local destinations is somewhat or very important. 92% of people surveyed also considered it somewhat or very important to have safe, convenient and connected walking and cycling paths, and access to public transport.

There is also widespread community support for investment in improving neighbourhoods to be more supportive of walking, wheeling and bike riding. Two Australian national surveys both found that two in three adult respondents were in favour of more government spending on walking and bike riding infrastructure,[184,185] including redirecting road funding towards this. Almost two-thirds were in favour of creating safer streets for people by reducing speed limits on local streets.[184] There is also good support for having more dedicated bike lanes separated from car traffic (52%), connected networks of footpaths and bike lanes (47%) and rest stops along footpaths and bike lanes (40%).[185] In 2021, a survey of more than 2,000 people in Australia found that 42% of respondents believed the government had not gone far enough to create bike lanes separated from cars to help people be healthy.[186]

Parents in Victoria have demonstrated support for infrastructure changes around schools to encourage walking and bike riding. In a survey of over 900 parents in Victoria, more than four in five supported measures such as widening footpaths to make space for a variety of users, introducing drop-and-walk points within walking distance of schools, adding more crossings around schools, and creating bike paths that are physically separated from car traffic.[187] Almost 70% supported reducing speed limits around schools to 30 km/h, while around half supported road closures around schools during peak times and developing shared streets.[187]

How important are the following to you in an ideal local neighbourhood?

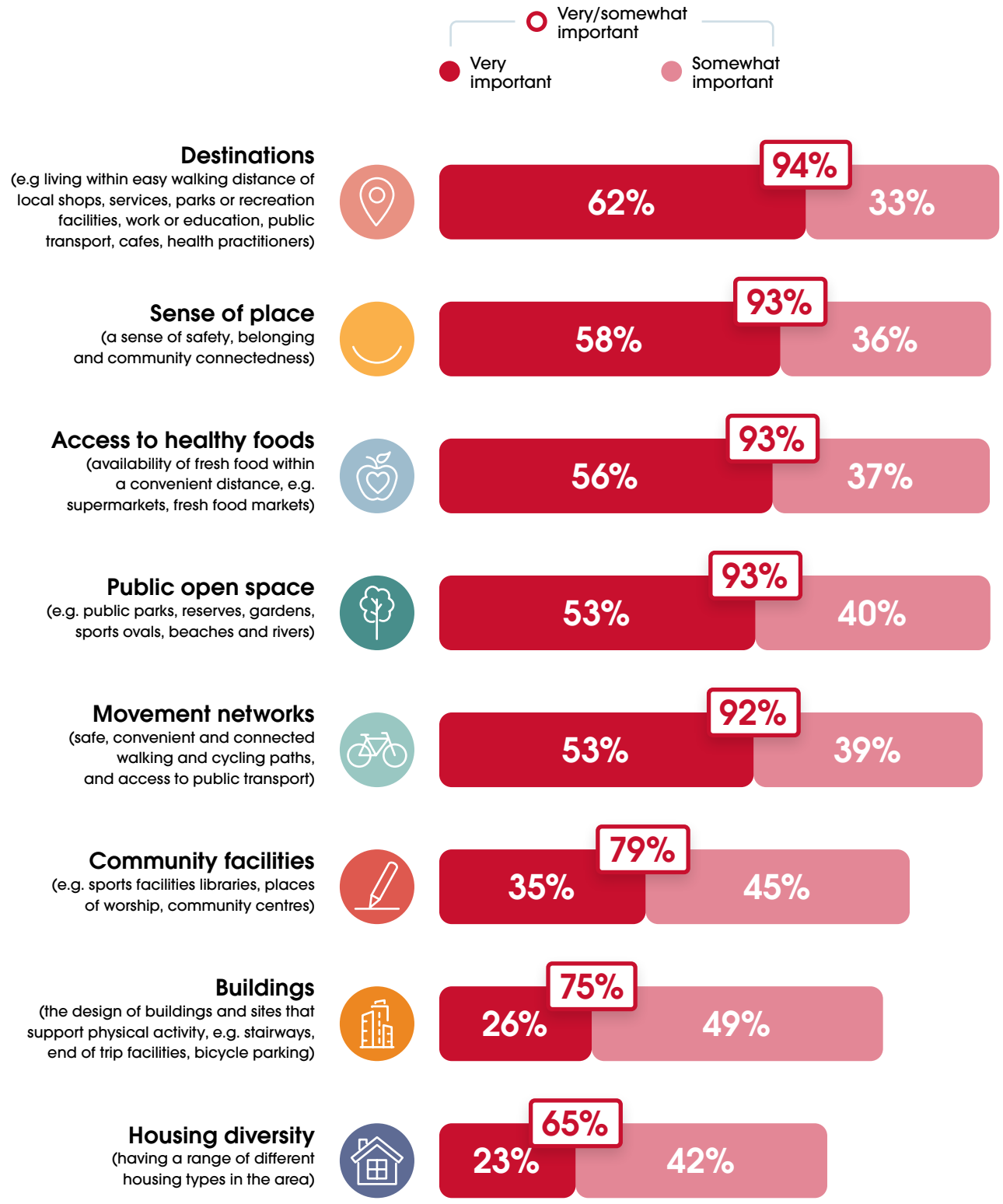

Figure 4: Results of the What Australia Wants: Neighbourhood Design survey[184]

3.2 Building awareness and communication messages

Engaging the public through strategic communication is key to generating support for 'people-first' approaches to road use, and can be helpful for countering potential opposition to these changes.[166] A survey of over 1,200 people living in Australia explored people's responses to messages that were framed around the the necessity and benefits of more walking, wheeling and bike riding. It was found that 25% respondents held consistently supportive views, 15% held consistent 'opponent' views, and 60% were 'persuadable'.[188]

Guidance for framing messages and effectively talking about walking, wheeling, bike riding and sustainable transport suggests that adopting the following principles may motivate those already supportive of change and nudge those who are persuadable:[185,188]

- promote streets as inclusive places for everyone, providing options and choices for more people, regardless of age and ability;
- humanise and normalise the use of streets by always referencing 'people' rather than pedestrians or cyclists, and use everyday terms like walking, riding bikes or e-bikes, and using a wheelchair (instead of active transport, bike riding, e-mobility, micro-mobility);
- use a positive frame by referring to solutions rather than problems or risks and avoiding negative or deficit language. Examples provided by guidance documents suggest terms like 'opening' opportunities or streets may appeal more than terms related to closing, replacing or removing;[185,188]
- appeal to values and emotions by focusing on benefits for everyone rather than personal benefits.

Motivations for supporting greater government investment in footpaths and bike lanes, as well as related infrastructure, policy and regulatory changes may include:

- providing more options to help people get around in a safe and affordable way
- enhancing mobility for those who can't or don't drive
- increasing the number of people who can travel in a way that doesn't worsen air quality or climate change
- improving health, well-being and quality of life.[185]

These motivations can help frame messages to enhance community support for walking, wheeling, bike riding and other active transport initiatives.

Guidance, tips and examples to support messaging for consumers can be found in these resources:

- Climate Change Council: Send the right signal: How to effectively talk about sustainable transport[185, i]
- VicHealth: Framing walking and bike riding. Message guide[188,ii]
- Heart Foundation: Community Walkability Checklist[iii]

i. https://www.climatecouncil.org.au/wp-content/uploads/2022/10/CC_MVSA0316-CC-Sustainable-Transport-Communications-Guide_V6-FA.pdf

ii. https://www.vichealth.vic.gov.au/sites/default/files/VBM-Framing-Walking-Bike-framing—message-guide.pdf

iii. https://www.healthyactivebydesign.com.au/community-walkability/checklist

Communication messages must focus on the benefits of a people-first approach to road design, including the promotion of streets as inclusive places. Image credit: iStock.com, eyecrave productions

4. People-first approaches

People-first approaches to street design and implementation that are good for heart health align with established frameworks (outlined below) and have a range of benefits (Box 4).

4.1 Movement and Place frameworks

Movement and Place frameworks[189,190] aim to balance two major functions of roads and streets: movement of people and goods from one place to another, and roads serving as a place. This people-centered approach puts people and communities at the heart of transport planning and road design. It allows integrated transport and land use planning by involving transport planners, urban planners, traffic engineers, and urban designers in a collaborative manner. The framework classifies roads and streets based on their land-use activities and similar combinations of users. For example, 'self-explaining streets'[191] are designed to match the users' expectations and behaviours to the intended function of the street, such as, knowing where to cross, walk, ride and how fast to go. In effect, the design of the street is intuitive and instructional for the users' behaviour. This may consequently produce safer road user behaviour and interactions between road users.[192]

4.2 Healthy Active by Design

Healthy Active by Design is the Heart Foundation's flagship program to improve the walkability of built environments. The multidisciplinary, award-winning program commenced in 2008. Extensive resources across eight design features and two supporting modules provide a pragmatic approach to translate evidence-based research into practical guidance to support the design, planning, delivery and ongoing management of built environments. The toolkit is intended for a wide range of industry professionals and other decision makers, to help shift awareness and attitudes to support a change in practice towards healthier, more active spaces and places.

BOX 4: People-first approaches to street design:

- Can help to improve levels of physical activity and reduce risk of cardiovascular disease
- View streets as public places
- Shift the hierarchy of road users to prioritise the needs and safety of people walking, wheeling or bike riding, rather than the movement of cars
- Can help amplify diverse voices in local community engagement and can draw on large scale surveys to deliver outcomes that match community desires
- Provide an equitable and inclusive design to meet the needs of a diverse range of people, including children, older adults, people with disability and different cultural backgrounds, making streets more accessible
- Ensure that walking, wheeling and bike riding are viable options for transport purposes
- Benefit everyone, including those who don't walk, wheel, ride or use public transport
- Can support local businesses
- Help to provide safe and efficient movement networks (not just spot improvements) for people on foot and bike
- Contribute to placemaking and provide locally-relevant solutions that can enhance the individual character and identity of an area, and to sense of place

5. Conclusion

Roads and streets are essential components of the public realm. Prioritising people in the design of streets and street systems is critical for enhancing the liveability of places, supporting a shift from dependence on cars to active, sustainable modes of travel, as well as promoting the use of streets as places for physical activity and social interaction.

Walking, wheeling, bike riding, active play and social interaction are important for heart health. Reducing car travel for short journeys not only benefits the heart but also supports environmental health. Creating inviting streets where people of all ages and abilities feel safe, and comfortable to walk, wheel or ride, and reach the places they need to go efficiently via these modes, are places for people.[77] Planning and design that considers how streets and road networks interact with surrounding neighbourhood features such as buildings, infrastructure and green spaces are critical for creating environments that prioritise people over cars. Good urban design can transform cities and towns, making them places where people are at the heart of road use.

6. Recommendations

Recommendations to put people at the heart of road use and promote heart health include:

1. Prioritise people-first approaches to street design and implementation at all levels of government. This could include greater adoption of frameworks such as Movement and Place, as well as design principles advocated by the Heart Foundation's flagship program, Healthy Active by Design.

Walking, wheeling and bike riding infrastructure

2. Provide high-quality infrastructure for people walking, such as wide, continuous footpaths, to support safe walking and wheeling by a range of users, including parents with small children, and provide separation from other forms of micromobility that travel faster than walking speed (e.g., traditional cycling and e-scooters).
3. Establish an extensive low-stress bike riding network that includes bike riding infrastructure physically separated from vehicular traffic on busy roads and designed to accommodate a range of micromobility users. These networks should offer connectivity and way finding to important daily living destinations, particularly local train stations, schools and shops, and consider safety and comfort for novice riders.
4. Ensure highly visible and universally accessible crossings are placed in logical, convenient locations leading to key destinations and increasing overall neighbourhood accessibility. Ensuring short wait times and adequate time to cross is critical, particularly for people with mobility challenges, older adults, and children.
5. Improve the connectivity of neighbourhoods for people walking, wheeling and bike riding via linear parks, cut-throughs and other measures. In particular, new developments should prioritise connected, grid-like street patterns with high intersection density and layouts to support more direct route options for walking, wheeling and bike riding.
6. Ensure universal accessibility of local street infrastructure so that it can be used safely by all people, including those with disability or limited mobility, older people and children. This infrastructure should be free from obstructions and designed to support independent movement for everyone.

Vehicular traffic

7. Reduce vehicular traffic speed and volume, particularly in local streets. This can be achieved by reducing posted speed limits (e.g., 30 km/hr), implementing physical traffic calming treatments, introducing modal filtering, and/or adopting area-wide approaches such as those central to Low Traffic Neighbourhoods (LTNs) or Superblocks.

Main streets

8. Create physically attractive main streets that people access by foot or bike. Incorporate greenery, lighting, public amenities and outdoor dining, which might also involve reallocating space from car parking to support these uses.

Communication

9. Build community awareness and support for people-first approaches to road use. Adopt values-based messaging principles to frame communications, grow support for walking, wheeling, bike riding and other active transport initiatives, which can help to counter potential opposition to road changes.

Strategic planning

10. Develop comprehensive neighbourhood-level plans that incorporate as many of the recommendations as applicable from this Heart of road use evidence review for maximum effect.

References

1. Cook S, Stevenson L, Aldred R, Kendall M, Cohen T. More than walking and cycling: What is 'active travel'? *Transport Policy.* 2022;126:151-161.
2. Wheels for Wellbeing. Active Travel Definitions: Walking/Wheeling, and Cycling. https://wheelsforwellbeing.org.uk/walking-wheeling-and-cycling-definitions/
3. Gray J. Pedestrian Connectivity through Culs-de-sac. Sustainable Development Code. 2025. https://sustainablecitycode.org/brief/pedestrian-connectivity-through-culs-de-sac/
4. Mekuria MC, Furth PG, Nixon H. Low-stress bicycling and network connectivity. Vol. Report 11-19. 2012. https://nacto.org/wp-content/uploads/1005-low-stress-bicycling-network-connectivity.pdf
5. Fishman E, Naseri M, Davies L, Tran J, Katsu T. Prioritising Active Transport. Vol. Austroads Publication No. AP-R711-24. 2024. https://austroads.gov.au/__data/assets/pdf_file/0031/653368/AP-R711-24_Prioritising_Active_Transport.pdf
6. Caspersen CJ, Powell KE, Christenson GM. Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. *Public Health Rep.* 1985;100(2):126-31.
7. Transport for NSW. Cycleway Design Toolbox Designing for cycling and micromobility. https://www.transport.nsw.gov.au/system/files?file=media/documents/2022/Cycleway-Design-Toolbox-Web_0.pdf
8. Tremblay MS, Aubert S, Barnes JD, et al. Sedentary Behavior Research Network (SBRN) – Terminology Consensus Project process and outcome. *International Journal of Behavioral Nutrition and Physical Activity.* 2017;14(1):75.
9. Lockwood I. ITE Traffic Calming Definition. *ITE Journal.* 1997;67(7):22.
10. Hill S, Cumpston Z, Quintana Vigiola G. Australia state of the environment 2021: urban. 2021. https://soe.dcceew.gov.au/urban/pressures/climate-change
11. Mattioli G, Roberts C, Steinberger JK, Brown A. The political economy of car dependence: A systems of provision approach. *Energy Res Soc Sci.* 2020;66:101486.
12. Norton PD. Fighting Traffic: The Dawn of the Motor Age in the American City. MIT Press; 2011.
13. Bureau of Infrastructure, Transport and Regional Economics (BITRE). *Traffic and congestion cost trends for Australian capital cities.* Information Sheet 74. 2015.
14. Jacobs J. The Death and Life of Great American Cities. Random House; 1961.
15. Gärling T, Steg L. Threats from Car Traffic to the Quality of Urban Life: Problems, Causes, and Solutions. Elsevier; 2007.
16. Henderson J. The Politics of Mobility: Deconstructing the U.S. Auto-City. MIT Press; 2009.
17. Gunn L, Kroen A, De Gruyter C, Higgs C, Saghapour T, Davern M. Early delivery of equitable and healthy transport options in new suburbs: Policy, place and people. *J Transp Health.* 2020;18:100870.
18. Bureau of Infrastructure and Transport Research Economics (BITRE). *Yearbook 2022: Australian Infrastructure and Transport Statistics, Statistical Report.* BITRE; 2022.
19. OECD. *OECD Regions and Cities at a Glance 2022.* OECD Publishing; 2022. Accessed 1 October, 2024. https://www.oecd-ilibrary.org/urban-rural-and-regional-development/private-vehicle-ownership-in-regions_e9bf85f2-en
20. Department of Transport and Main Roads. *Queensland household travel survey interactive report (South east Queensland 2018).* Accessed 4 Nov, 2024. file:///C:/Users/timperio/Downloads/SEQ-Household-Travel-Survey-2018-dashboards.pdf

21. Department of Transport. Trips - method of travel. *VISTA - Trips - 2008 to 2020 by Victorian Integrated Survey of Travel & Activity (VISTA)*. 14 Feb, 2023 ed. State Government of Victoria; 2923. Accessed 4 November, 2024. https://public.tableau.com/app/profile/vista/viz/VISTA-TripsDraft/Trips-methodoftravel
22. Department of State Growth. Travel in Greater Hobart: Household Travel Survey 2019. Accessed 4 Nov, 2024. https://www.transport.tas.gov.au/__data/assets/pdf_file/0004/453199/Greater_Hobart_Household_Travel_Survey.pdf
23. Sift Research. ACT & Queanbeyan Household Travel Survey 2022: TRAVEL OVERVIEW. 2023.
24. Transport for NSW. *Data by Region (Post-COVID (2020 onwards), Trip Characteristics*. Accessed 4 Nov, 2024. https://www.transport.nsw.gov.au/data-by-region
25. Australian Bureau of Statistics. Australia's journey to work. Australian Bureau of Statistics; 2022. 3/11/2022. https://www.abs.gov.au/articles/australias-journey-work
26. Saeidizand P, Boussauw K. Patterns of car dependency of metropolitan areas worldwide: Learning from the outliers. *Int J Sustain Transp*. 2024;18(3):221-235.
27. Kenworthy JR, Laube FB. Patterns of automobile dependence in cities: an international overview of key physical and economic dimensions with some implications for urban policy. *Transportation Research Part A: Policy and Practice*. 1999;33(7):691-723.
28. Cervero R, Murakami J. Effects of Built Environments on Vehicle Miles Traveled: Evidence from 370 US Urbanized Areas. *Environ Plan A*. 2010;42(2):400-418.
29. Sierra Muñoz J, Duboz L, Pucci P, Ciuffo B. Why do we rely on cars? Car dependence assessment and dimensions from a systematic literature review. *Eur Transport Res Rev*. 2024;16(1):17.
30. Bureau of Infrastructure, Transport and Regional Economics. *Relationship between transport use and income in Australia*. Information Sheet 102. BITRE; 2019.
31. Owen N, Healy GN, Dempsey PC, et al. Sedentary Behavior and Public Health: Integrating the Evidence and Identifying Potential Solutions. *Annu Rev Public Health*. 2020;41:265-287.
32. Sugiyama T, Chandrabose M, Homer AR, Sugiyama M, Dunstan DW, Owen N. Car use and cardiovascular disease risk: Systematic review and implications for transport research. *J Transp Health*. 2020;19:100930.
33. Sugiyama T, Wijndaele K, Koohsari MJ, Tanamas SK, Dunstan DW, Owen N. Adverse associations of car time with markers of cardio-metabolic risk. *Prev Med* 2016;83:26-30.
34. Warren TY, Barry V, Hooker SP, Sui XM, Church TS, Blair SN. Sedentary Behaviors Increase Risk of Cardiovascular Disease Mortality in Men. *Med Sci Sports Exerc*. 2010;42(5):879-885.
35. Kent JL, Mulley C, Stevens N. Transport and wellbeing in a newly constructed greenfield estate: A quantitative exploration of the commuting experience. Article. *J Transp Health*. 2019;13:210-223.
36. Xia T, Nitschke M, Zhang Y, Shah P, Crabb S, Hansen A. Traffic-related air pollution and health co-benefits of alternative transport in Adelaide, South Australia. *Environ Int*. 2015;74:281-90.
37. Rajagopalan S, Al-Kindi SG, Brook RD. Air Pollution and Cardiovascular Disease: JACC State-of-the-Art Review. *J Am Coll Cardiol*. 2018;72(17):2054-2070.
38. Van Kempen E, Casas M, Pershagen G, Foraster M. WHO Environmental Noise Guidelines for the European Region: A Systematic Review on Environmental Noise and Cardiovascular and Metabolic Effects: A Summary. *Int J Environ Res Public Health*. 2018;15(2). doi:10.3390/ijerph15020379
39. Jemielita P, Lip GYH, Kurasz A, et al. Noise and light exposure and cardiovascular outcomes: A review of evidence, potential mechanisms and implications. *Trends in Cardiovascular Medicine*. 2024;
40. Kraus WE, Powell KE, Haskell WL, et al. Physical Activity, All-Cause and Cardiovascular Mortality, and Cardiovascular Disease. *Med Sci Sports Exerc*. 2019;51(6):1270-1281.

41. Poitras VJ, Gray CE, Borghese MM, et al. Systematic review of the relationships between objectively measured physical activity and health indicators in school-aged children and youth. *Appl Physiol Nutr Metab*. 2016;41:S197–S239.
42. Ekelund U, Luan J, Sherar LB, Esliger DW, Griew P, Cooper A. Moderate to vigorous physical activity and sedentary time and cardiometabolic risk factors in children and adolescents. *JAMA*. 2012;307(7):704-12.
43. Physical Activity Guidelines Advisory Committee. *2018 physical activity guidelines Advisory Committee scientific report*. US Department of Health and Human Services; 2018.
44. Shilton T, Bauman A, Beger B, et al. More People, More Active, More Often for Heart Health - Taking Action on Physical Activity. *Glob Heart*. 2024;19(1):42.
45. Zapata-Diomedi B, Both A, Abbas A, et al. Shifting car travel to active modes to improve population health and achieve transport goals: A simulation study. *J Transp Health*. 2023;31:101628.
46. Mueller N, Rojas-Rueda D, Cole-Hunter T, et al. Health impact assessment of active transportation: A systematic review. *Prev Med*. 2015;76:103-14.
47. Loukaitou-Sideris A. Special issue on walking. *Transport Reviews*. 2020;40(2):131-134.
48. Martin A, Boyle J, Corlett F, Kelly P, Reilly JJ. Contribution of Walking to School to Individual and Population Moderate-Vigorous Intensity Physical Activity: Systematic Review and Meta-Analysis. *Pediatr Exerc Sci*. 2016;28(3):353-63.
49. Schoeppe S, Duncan MJ, Badland H, Oliver M, Curtis C. Associations of children's independent mobility and active travel with physical activity, sedentary behaviour and weight status: A systematic review. *J Sci Med Sport*. 2013;16(4):312-319.
50. Larouche R, Saunders TJ, Faulkner G, Colley R, Tremblay M. Associations between active school transport and physical activity, body composition, and cardiovascular fitness: a systematic review of 68 studies. *J Phys Act Health*. 2014;11(1):206-27.
51. Paluch AE, Bajpai S, Ballin M, et al. Prospective Association of Daily Steps With Cardiovascular Disease: A Harmonized Meta-Analysis. *Circulation*. 2023;147(2):122-131.
52. Grontved A, Rasmussen MG, Blond K, Ostergaard L, Andersen ZJ, Moller NC. Bicycling for transportation and recreation in cardiovascular disease prevention. *Curr Cardiovasc Risk Rep*. 2019;13:26.
53. Lubans DR, Boreham CA, Kelly P, Foster CE. The relationship between active travel to school and health-related fitness in children and adolescents: a systematic review. *Int J Behav Nutr Phys Act*. 2011;8:5.
54. Bourne JE, Sauchelli S, Perry R, et al. Health benefits of electrically-assisted cycling: a systematic review. *Int J Behav Nutr Phys Act*. 2018;15(1):116.
55. McVicar J, Keske MA, Daryabeygi-Khotbehsara R, Betik AC, Parker L, Maddison R. Systematic review and meta-analysis evaluating the effects electric bikes have on physiological parameters. *Scand J Med Sci Sport*. 2021;32:1076-1088.
56. Evans JT, Stanesby O, Blizzard L, et al. Is public transport a promising strategy for increasing physical activity? Evidence from a study of objectively measured public transport use and physical activity. *Int J Behav Nutr Phys Act*. 2024;21(1):91.
57. Rissel C, Curac N, Greenaway M, Bauman A. Physical activity associated with public transport use–a review and modelling of potential benefits. *Int J Environ Res Public Health*. 2012;9(7):2454-78.
58. Patterson R, Webb E, Hone T, Millett C, Laverty AA. Associations of Public Transportation Use With Cardiometabolic Health: A Systematic Review and Meta-Analysis. *Am J Epidemiol*. 2019;188(4):785-795.

59. Stock P, Steffen W, Bourne G, Brailsford L. *Waiting for the Green Light: Transport Solutions to Climate Change*. Climate Council of Australia; 2018.
60. Piracha A, Chaudhary MT. Urban Air Pollution, Urban Heat Island and Human Health: A Review of the Literature. *Sustainability*. 2022;14(15). doi:10.3390/su14159234
61. Ulpiani G. On the linkage between urban heat island and urban pollution island: Three-decade literature review towards a conceptual framework. *Science of The Total Environment*. 2021;751:141727.
62. Brand C, Dons E, Anaya-Boig E, et al. The climate change mitigation effects of daily active travel in cities. *Transportation Research Part D: Transport and Environment*. 2021;93:102764.
63. Intergovernmental Panel on Climate Change. *Climate Change 2022 - Mitigation of Climate Change*. Cambridge University Press; 2023.
64. Salvo D, Garcia L, Reis RS, et al. Physical activity promotion and the United Nations Sustainable Development Goals: Building synergies to maximize impact. *J Phys Act Health*. 2021;18:1163-1180.
65. Jones SJ. If electric cars are the answer, what was the question? *Br Med Bull*. 2019;129(1):13-23.
66. Popovich N, Handy SL. Bicyclists as Consumers: Mode Choice and Spending Behavior in Downtown Davis, California. *Transportation Research Record*. 2014;2468(1):47-54.
67. Clifton KJ, Muhs CD, Morrissey S, Morrissey T, Currans KM, Ritter C. *Examining consumer behavior and travel choices*. OTREC-RR-12-15. 2013.
68. Waygood EOD. Chapter Four - Transport and social wellbeing. In: Waygood EOD, Friman M, Olsson LE, Mitra R, eds. *Transport and Children's Wellbeing*. Elsevier; 2020:61-80.
69. Smith M, Calder-Dawe O, Carroll P, et al. Mobility barriers and enablers and their implications for the wellbeing of disabled children and young people in Aotearoa New Zealand: A cross-sectional qualitative study. *Wellbeing, Space and Society*. 2021;2:100028.
70. Ramanathan S, O'Brien C, Faulkner G, Stone M. Happiness in Motion: Emotions, Well-Being, and Active School Travel. *J School Health*. 2014;84(8):516-523.
71. Leung KYK, Loo BPY. Association of children's mobility and wellbeing: A case study in Hong Kong. *Travel Behaviour and Society*. 2017;9:95-104.
72. Frömel K, Groffik D, Mitáš J, Dygrýn J, Valach P, Šafář M. Active Travel of Czech and Polish Adolescents in Relation to Their Well-Being: Support for Physical Activity and Health. *Int J Environ Res Public Health*. 2020;17(6). doi:10.3390/ijerph17062001
73. Sun Y, Liu Y, Tao FB. Associations Between Active Commuting to School, Body Fat, and Mental Well-being: Population-Based, Cross-Sectional Study in China. *J Adolesc Health*. 2015;57(6):679-85.
74. Jin Y, Carson V, Pabayo R, Spence JC, Tremblay M, Lee E-Y. Associations between utilitarian walking, meeting global physical activity guidelines, and psychological well-being among South Korean adolescents. *J Transp Health*. 2019;14:100588.
75. Rambaldini-Gooding D, Molloy L, Parrish A-M, et al. Exploring the impact of public transport including free and subsidised on the physical, mental and social well-being of older adults: a literature review. *Transport Reviews*. 2021;41(5):600-616.
76. Kelly J-F, Breadon P, Davis C, et al. *Social Cities*. 2012.
77. Australia: Department of Infrastructure and Transport, Australian Sustainable Built Environment Council. *Creating Places for People - an urban design protocol for Australian Cities*. https://urbandesign.org.au/content/uploads/2015/08/INFRA1219_MCU_R_SQUARE_URBAN_PROTOCOLS_1111_WEB_FA2.pdf
78. World Health Organization. Walking and cycling: latest evidence to support policy-making and practice. 2022.
79. Pedestrian safety: a road safety manual for decision-makers and practitioners (2nd edition). 2023.

80. World Health Organization. *Global Plan: Decade of action for road safety, 2021-2030*. https://cdn.who.int/media/docs/default-source/documents/health-topics/road-traffic-injuries/global-plan-for-road-safety.pdf?sfvrsn=65cf34c8_35&download=true
81. European Transport Safety Council. Amsterdam follows Paris, Brussels and Madrid with default 30 km/h limits. 29/10/2024, https://etsc.eu/amsterdam-follows-paris-brussels-and-madrid-with-default-30-km-h-limits
82. Government W. Introducing default 20mph speed limits. Welsh Government. Updated 25 September, 2024. Accessed 20 January, 2025. https://www.gov.wales/introducing-default-20mph-speed-limits
83. Pilkington P, Bornioli A, Bray I, Bird E. *The Bristol Twenty Miles Per Hour Limit Evaluation (BRITE) Study*. University of the West of England; 2018.
84. Dexter R. Speed limit cut to 30km/h on almost every stret in two suburbs. *The Age*. Accessed 28/10/2024. https://www.theage.com.au/national/victoria/collingwood-and-fitzroy-streets-drop-to-30km-h-from-today-20240509-p5in8u.html
85. Kim H, Jung D. Estimation of Optimal Speed Limits for Urban Roads Using Traffic Information Big Data. *Applied Sciences*. 2021;11(12). doi:10.3390/app11125710
86. Luo M, Li H, Pan X, et al. Neighbourhood speed limit and childhood obesity. *Obes Rev*. 2021;22 Suppl 1(Suppl 1):e13052.
87. Yannis G, Michelaraki E. Review of City-Wide 30 km/h Speed Limit Benefits in Europe. *Sustainability*. 2024;16(11). doi:10.3390/su16114382
88. Rossi IA, Vienneau D, Ragettli MS, Flückiger B, Röösli M. Estimating the health benefits associated with a speed limit reduction to thirty kilometres per hour: A health impact assessment of noise and road traffic crashes for the Swiss city of Lausanne. *Environ Int*. 2020;145:106126.
89. Wei J, Wu Y, Zheng J, Nie P, Jia P, Wang Y. Neighborhood sidewalk access and childhood obesity. *Obes Rev*. 2021;22(S1):e13057.
90. Lee C, Zhu X, Yoon J, Varni JW. Beyond Distance: Children's School Travel Mode Choice. *Ann Behav Med*. 2013;45(1):S55–S67.
91. Barnett DW, Barnett A, Nathan A, et al. Built environmental correlates of older adults' total physical activity and walking: a systematic review and meta-analysis. *Int J Behav Nutr Phys Act*. 2017;14(1):103.
92. Cerin E, Nathan A, van Cauwenberg J, Barnett DW, Barnett A. The neighbourhood physical environment and active travel in older adults: a systematic review and meta-analysis. *Int J Behav Nutr Phys Act*. 2017;14(1):15.
93. Sallis JF, Bowles HR, Bauman A, et al. Neighborhood environments and physical activity among adults in 11 countries. *Am J Prev Med*. 2009;36(6):484-90.
94. Twardzik E, Clarke P, Judd S, Colabianchi N. Neighborhood Participation Is Less Likely among Older Adults with Sidewalk Problems. *J Aging Health*. 2021;33(1-2):101-113.
95. Loukaitou-Sideris A, Ehrenfeucht R. The Social, Economic and Political Life of Sidewalks. *Public Space Reader*. 2021:332-339.
96. Loukaitou-Sideris A. The right to walk in the Neighborhood. Designing inclusive sidewalks for older adults. In: Goh K, Loukaitou-Sideris A, Mukhija V, eds. *Just Urban Design: The Struggle for a Public City*. MIT Press; 2022:295-314.
97. Moran M, Van Cauwenberg J, Hercky-Linnewiel R, Cerin E, Deforche B, Plaut P. Understanding the relationships between the physical environment and physical activity in older adults: a systematic review of qualitative studies. *Int J Behav Nutr Phys Act*. 2014;11:79.
98. Li W, Keegan THM, Sternfeld B, Sidney S, Quesenberry CP, Kelsey JL. Outdoor Falls Among Middle-Aged and Older Adults: A Neglected Public Health Problem. *Am J Public Health*. 2006;96(7):1192-1200.

99. Dunlap PM, Fan EK, Hubbard ZL, VonVille HM, Strotmeyer ES, Rosso AL. Outdoor Environmental Risk Factors for Falls and Fear of Falling: A Systematic Review. *Gerontologist*. 2025;
100. Stafford L, Adkins B, Franz J. Bounded at the driveway's edge: body-space tensions encountered by children with mobility impairments in moving about the neighbourhood street. *Child Geogr*. 2020;18(3):298-311.
101. Coppola NA, Marshall WE. Sidewalk Static Obstructions and Their Impact on Clear Width. *Transportation Research Record*. 2021;2675(6):200-212.
102. Georgescu A-I, Allahbakhshi H, Weibel R. The impact of microscale street elements on active transport of mobility-restricted individuals: A systematic review. *J Transp Health*. 2024;38:101842.
103. Bridge G. Equitable mobility: enhancing walkability and rollability for inclusive and healthy communities. *Cities Health*. 2025:1-5.
104. Kapsalis E, Jaeger N, Hale J. Disabled-by-design: effects of inaccessible urban public spaces on users of mobility assistive devices - a systematic review. *Disabil Rehabil Assist Technol*. 2024;19(3):604-622.
105. Lee RE, Soltero EG, Jáuregui A, et al. Disentangling Associations of Neighborhood Street Scale Elements With Physical Activity in Mexican School Children. *Environ Behav*. 2016;48(1):150-171.
106. Šucha M, Drimlová E, Rečka K, et al. E-scooter riders and pedestrians: Attitudes and interactions in five countries. *Heliyon*. 2023;9(4):e15449.
107. Sikka N, Vila C, Stratton M, Ghassemi M, Pourmand A. Sharing the sidewalk: A case of E-scooter related pedestrian injury. *Am J Emerg Med*. 2019;37(9):1807.e5-1807.e7.
108. Mesimäki J, Luoma J. Near accidents and collisions between pedestrians and cyclists. *Eur Transport Res Rev*. 2021;13(1):38.
109. Pan X, Zhao L, Luo J, et al. Access to bike lanes and childhood obesity: A systematic review and meta-analysis. *Obes Rev*. 2021;22 Suppl 1(Suppl 1)(1):e13042.
110. Yang Y, Wu X, Zhou P, Gou Z, Lu Y. Towards a cycling-friendly city: An updated review of the associations between built environment and cycling behaviors (2007–2017). *J Transp Health*. 2019;14:100613.
111. Stappers NEH, Van Kann DHH, Ettema D, De Vries NK, Kremers SPJ. The effect of infrastructural changes in the built environment on physical activity, active transportation and sedentary behavior - A systematic review. *Health Place*. 2018;53:135-149.
112. Panter J, Guell C, Humphreys D, Ogilvie D. Can changing the physical environment promote walking and cycling? A systematic review of what works and how. *Health Place*. 2019;58:102161.
113. Mölenberg FJM, Panter J, Burdorf A, van Lenthe FJ. A systematic review of the effect of infrastructural interventions to promote cycling: strengthening causal inference from observational data. *Int J Behav Nutr Phys Act*. 2019;16(1):93.
114. Pearson L, Gabbe B, Reeder S, Beck B. Barriers and enablers of bike riding for transport and recreational purposes in Australia. *J Transp Health*. 2023;28:101538.
115. Pearson L, Dipnall J, Gabbe B, et al. The potential for bike riding across entire cities: Quantifying spatial variation in interest in bike riding. *J Transp Health*. 2022;24:101290.
116. Jensen SU. Bicycle tracks and lanes: A before-after study. *Transportation Research Board 87th Annual Meeting*. Transportation Research Board; 2008.
117. Autelitano F, Giuliani F. Colored bicycle lanes and intersection treatments: International overview and best practices. *J Traffic Transp Eng*. 2021;8(3):399-420.
118. DiGioia J, Watkins KE, Xu Y, Rodgers M, Guensler R. Safety impacts of bicycle infrastructure: A critical review. *J Safety Res*. 2017;61:105-119.
119. Dill J, Monsere CM, McNeil N. Evaluation of bike boxes at signalized intersections. *Accid Anal Prev*. 2012;44(1):126-134.

120. van Petegem JH, Schepers P, Wijlhuizen GJ. The safety of physically separated cycle tracks compared to marked cycle lanes and mixed traffic conditions in Amsterdam. *Eur J Transport Infrastructure Res*. 2021;21(3):19-37.
121. Monsere C, Dill J, McNeil N, et al. Lessons from the Green Lanes: Evaluating protected bike lanes in the US. 2014.
122. Pearson L, Reeder S, Gabbe B, Beck B. What a girl wants: A mixed-methods study of gender differences in the barriers to and enablers of riding a bike in Australia. *Transportation Research Part F: Traffic Psychology and Behaviour*. 2023;94:453-465.
123. Pucher J, Buehler R. Making Cycling Irresistible: Lessons from The Netherlands, Denmark and Germany. *Transport Reviews*. 2008;28(4):495-528.
124. Smith ML, Fu X. When bike lanes are not enough: The role of connected low-stress cycling infrastructure on cycle commuting in urban Aotearoa New Zealand. *Cities*. 2025;156:105526.
125. Kraus S, Koch N. Provisional COVID-19 infrastructure induces large, rapid increases in cycling. *Proc Natl Acad Sci U S A*. 2021;118(15)
126. Buehler R, Pucher J. Cycling through the COVID-19 Pandemic to a More Sustainable Transport Future: Evidence from Case Studies of 14 Large Bicycle-Friendly Cities in Europe and North America. *Sustainability*. 2022;14(12). doi:10.3390/su14127293
127. Harris M, McCue P. Pop-Up Cycleways. *J Am Plan Assoc*. 2023;89(2):240-252.
128. Younes H, Andrews C, Noland RB, et al. The Traffic Calming Effect of Delineated Bicycle Lanes. *J Urban Mobil*. 2024;5:100071.
129. Leden L, Gårder P, Johansson C. Safe pedestrian crossings for children and elderly. *Accid Anal Prev*. 2006;38(2):289-294.
130. Kelly CE, Tight MR, Hodgson FC, Page MW. A comparison of three methods for assessing the walkability of the pedestrian environment. *J Transp Geog*. 2011;19(6):1500-1508.
131. Timperio A, Ball K, Salmon J, et al. Personal, family, social, and environmental correlates of active commuting to school. *Am J Prev Med*. 2006;30(1):45-51.
132. Trapp GS, Giles-Corti B, Christian HE, et al. Increasing children's physical activity: individual, social, and environmental factors associated with walking to and from school. *Health Educ Behav*. 2012;39(2):172-82.
133. Trapp GS, Giles-Corti B, Christian HE, et al. On your bike! a cross-sectional study of the individual, social and environmental correlates of cycling to school. *Int J Behav Nutr Phys Act*. 2011;8:123.
134. Amaya V, Chardon M, Moulaert T, Vuillerme N. Systematic Review of the Use of the Walk-Along Interview Method to Assess Factors, Facilitators and Barriers Related to Perceived Neighborhood Environment and Walking Activity in Healthy Older Adults. *Sustainability*. 2024;16(2). doi:10.3390/su16020882
135. Sisiopiku VP, Akin D. Pedestrian behaviors at and perceptions towards various pedestrian facilities: an examination based on observation and survey data. *Transportation Research Part F: Traffic Psychology and Behaviour*. 2003;6(4):249-274.
136. Cantillo V, Arellana J, Rolong M. Modelling pedestrian crossing behaviour in urban roads: A latent variable approach. *Transportation Research Part F: Traffic Psychology and Behaviour*. 2015;32:56-67.
137. Bi H, Li A, Zhu H, Ye Z. Bicycle safety outside the crosswalks: Investigating cyclists' risky street-crossing behavior and its relationship with built environment. *J Transp Geog*. 2023;108:103551.
138. Duim E, Lebrão ML, Antunes JLF. Walking speed of older people and pedestrian crossing time. *J Traffic Transp Eng*. 2017;5:70-76.
139. Koohsari MJ, Oka K, Owen N, Sugiyama T. Natural movement: A space syntax theory linking urban form and function with walking for transport. *Health Place*. 2019;58:102072.

140. Gunn LD, Mavoa S, Boulangé C, Hooper P, Kavanagh A, Giles-Corti B. Designing healthy communities: creating evidence on metrics for built environment features associated with walkable neighbourhood activity centres. *Int J Behav Nutr Phys Act*. 2017;14(1):164.
141. Cerin E, Sallis JF, Salvo D, et al. Determining thresholds for spatial urban design and transport features that support walking to create healthy and sustainable cities: findings from the IPEN Adult study. *The Lancet Global Health*. 2022;10(6):e895-e906.
142. Boeing G, Higgs C, Liu S, et al. Using open data and open-source software to develop spatial indicators of urban design and transport features for achieving healthy and sustainable cities. *Lancet Glob Health*. 2022;10(6):e907-e918.
143. Bentley R, Blakely T, Kavanagh A, et al. A Longitudinal Study Examining Changes in Street Connectivity, Land Use, and Density of Dwellings and Walking for Transport in Brisbane, Australia. *Environ Health Perspect*. 2018;126(5):057003.
144. Christian H, Knuiman M, Divitini M, et al. A Longitudinal Analysis of the Influence of the Neighborhood Environment on Recreational Walking within the Neighborhood: Results from RESIDE. *Environ Health Perspect*. 2017;125(7):077009.
145. Jafari A, Pemberton S, Singh D, et al. Understanding the impact of city-wide cycling corridors on cycling mode share among different demographic clusters in Greater Melbourne, Australia. *J Transp*. 2025; 1;28
146. Chandrabose M, Cerin E, Mavoa S, et al. Neighborhood walkability and 12-year changes in cardio-metabolic risk: the mediating role of physical activity. *Int J Behav Nutr Phys Act*. 2019;16(1):86.
147. Molaei P, Alidadi M, Badland H, Gunn L. Associations between the urban neighbourhood built and social environment characteristics with physical functioning among mid- and older-aged adults: A systematic review. *Social Science & Medicine*. 2024;362:117412.
148. Cozens P, Hillier D. The Shape of Things to Come: New Urbanism, the Grid and the Cul-De-Sac. *Int Plan Stud*. 2008;13(1):51-73.
149. Torres A, Sarmiento OL, Stauber C, Zarama R. The ciclovia and cicloruta programs: promising interventions to promote physical activity and social capital in Bogotá, Colombia. *Am J Prev Med* 2013;103(2):e23-e30.
150. Aldred R, Croft J. Evaluating active travel and health economic impacts of small streetscape schemes: An exploratory study in London. *J Transp Health*. 2019;12:86-96.
151. Mertens L, Compernolle S, Deforche B, et al. Built environmental correlates of cycling for transport across Europe. *Health Place*. 2017;44:35-42.
152. Yu J, Zhang H, Dong X, Shen J. The impact of street greenery on active travel: a narrative systematic review. *Front Public Health*. 2024;12:1337804.
153. Vidal-Tortosa E, Lovelace R. Road lighting and cycling: A review of the academic literature and policy guidelines. *J Cycling Micromobility Res*. 2024;2:100008.
154. Tabatabaie S, Litt JS, Muller BHF. Sidewalks, trees and shade matter: A visual landscape assessment approach to understanding people's preferences for walking. *Urban Forestry & Urban Greening*. 2023;84:127931.
155. Corseuil Giehl MW, Hallal PC, Brownson RC, d'Orsi E. Exploring Associations Between Perceived Measures of the Environment and Walking Among Brazilian Older Adults. *J Aging Health*. 2017;29(1):45-67.
156. Park Y, Garcia M. Pedestrian safety perception and urban street settings. *Int J Sustain Transp*. 2020;14(11):860-871.
157. Paydar M, Kamani Fard A. The impact of legibility and seating areas on social interaction in the neighbourhood park and plaza. *Archnet-IJAR*. 2021;15(3):571-588.

158. Australia Post. 2024 Inside Australian Online Shopping. Accessed 19 January, 2025, 2025. https://auspost-report.s3.ap-southeast-2.amazonaws.com/eCommerce+Industry+Report+2024+-+Trends+in+eCommerce+section.pdf
159. URBIS. Attractive streets attract more people. Accessed 19 January, 2025, 2025. https://urbis.com.au/insights-news/attractive-streets-attract-more-people/
160. Transport for NSW. *Impact Report: Activating Streets and Centres across NSW*. 2022. https://www.transport.nsw.gov.au/system/files/media/documents/2023/Impact-Report-Activating-Streets-and-Centres-across-NSW.pdf
161. Sarmiento OL, Díaz del Castillo A, Triana CA, Acevedo MJ, Gonzalez SA, Pratt M. Reclaiming the streets for people: Insights from Ciclovías Recreativas in Latin America. *Prev Med*. 2017;103:S34-S40.
162. Cervero R, Sarmiento OL, Jacoby E, Gomez LF, Neiman A. Influences of Built Environments on Walking and Cycling: Lessons from Bogotá. *Int J Sustain Transp*. 2009;3(4):203-226.
163. Gómez LF, Parra DC, Buchner D, et al. Built environment attributes and walking patterns among the elderly population in Bogotá. *Am J Prev Med* 2010b;38(6):592-599.
164. Umstattd Meyer MR, Bridges CN, Schmid TL, Hecht AA, Pollack Porter KM. Systematic review of how Play Streets impact opportunities for active play, physical activity, neighborhoods, and communities. *BMC Public Health*. 2019;19(1):335.
165. Triana CA, Sarmiento OL, Bravo-Balado A, et al. Active streets for children: The case of the Bogotá Ciclovía. *PLOS ONE*. 2019;14(5):e0207791.
166. Young DR, Cradock AL, Eyler AA, et al. Creating Built Environments That Expand Active Transportation and Active Living Across the United States: A Policy Statement From the American Heart Association. *Circulation*. 2020;142(11):e167-e183.
167. Anderson G, Searfoss L, Cox A, et al. *Safer streets. stronger economies: Complete Streets project outcomes from across the country*. 2015. Accessed 28/10/2024. https://smartgrowthamerica.org/wp-content/uploads/2016/08/safer-streets-stronger-economies.pdf
168. Brown BB, Smith KR, Tharp D, et al. A Complete Street Intervention for Walking to Transit, Nontransit Walking, and Bicycling: A Quasi-Experimental Demonstration of Increased Use. *J Phys Act Health*. 2016;13(11):1210-1219.
169. Aldred R, Croft J, Goodman A. Impacts of an active travel intervention with a cycling focus in a suburban context: One-year findings from an evaluation of London's in-progress mini-Hollands programme. *Transportation Research Part A: Policy and Practice*. 2019;123:147-169.
170. Aldred R, Goodman A, Woodcock J. Impacts of active travel interventions on travel behaviour and health: Results from a five-year longitudinal travel survey in Outer London. *J Transp Health*. 2024;35:101771.
171. Goodman A, Urban S, Aldred R. The Impact of Low Traffic Neighbourhoods and Other Active Travel Interventions on Vehicle Ownership: Findings from the Outer London Mini-Holland Programme. *Findings*. 2020. doi:https://doi.org/10.32866/001c.18200
172. Goodman A, Aldred R. The Impact of Introducing a Low Traffic Neighbourhood on Street Crime, in Waltham Forest, London. *Findings*. 2021. May, 2021. https://doi.org/10.32866/001c.19414
173. Laverty AA, Aldred R, Goodman A. The Impact of Introducing Low Traffic Neighbourhoods on Road Traffic Injuries. *Findings*. 2021. January, 2021. doi:https://doi.org/10.32866/001c.18330
174. Goodman A, Laverty AA, Thomas A, Aldred R. The Impact of 2020 Low Traffic Neighbourhoods on Fire Service Emergency Response Times, in London, UK. *Findings*. 2021. May, 2021. https://doi.org/10.32866/001c.23568
175. Xiao CS, Sinclair N, Saunders L, Panter J. Evaluating the impact of low traffic neighbourhoods in areas with low car ownership: A natural experimental evaluation. *J Transp Health*. 2023;33:101658.

176. Mueller N, Rojas-Rueda D, Khreis H, et al. Changing the urban design of cities for health: The superblock model. *Environ Int*. 2020;134:105132.
177. Nieuwenhuijsen M, de Nazelle A, Pradas MC, et al. The Superblock model: A review of an innovative urban model for sustainability, liveability, health and well-being. *Environ Res*. 2024;251:118550.
178. Cash-Gibson L, Diaz AB, Sardà OM, Benach J. How do superblock interventions influence health? A scoping review. Cities. 2024;153:105262.
179. Mackie H, Macmillan A, Witten K, et al. Te Ara Mua - Future Streets suburban street retrofit: A researcher-community-government co-design process and intervention outcomes. *J Transp Health*. 2018;11:209-220.
180. Hosking J, Mackie H, Macmillan A, et al. Effects of Te Ara Mua – Future Streets suburban street retrofit on traffic speed and volume: Controlled before-after study. *J Transp Health*. 2023;30:101601.
181. Hirsch L, Mackie H, Crombie C, Bolton L, Wilson N, Cornille Z. Road user interaction changes following street improvements from Te Ara Mua – Future Streets: A case study. *J Transp Health*. 2022;25:101384.
182. Witten K, Macmillan A, Mackie H, et al. Te Ara Mua – Future Streets: Can a streetscape upgrade designed to increase active travel change residents' perceptions of neighbourhood safety? *Wellbeing, Space and Society*. 2022;3:100079.
183. Adhikari A, Ryan M, Harrington M. Proactive investment: Policies to increase rates of active transportation. The Australia Institute; 2024. https://australiainstitute.org.au/wp-content/uploads/2024/10/P1682-Policies-to-increase-rates-of-active-transportation-Web.pdf
184. National Heart Foundation of Australia. *What Australia Wants: Neighbourhood Design,* National Heart Foundation of Australia, 2025.
185. Arndt D, Dickson E, in partnership with MMResearch and YouGov. *Send the right signal: how to effectively talk about sustainable transport*. Climate Council of Australia Limited; 2020. Accessed 2 October, 2024. https://www.climatecouncil.org.au/wp-content/uploads/2022/10/CC_MVSA0316-CC-Sustainable-Transport-Communications-Guide_V6-FA.pdf
186. Grunseit A. *AUSPOPS 2016–2021: Third national report*. The Australian Prevention Partnership Centre; 2021.
187. Sahlqvist S, Lim K, Loh V, Veitch J, Salmon J, Timperio A. Understanding parental support for infrastructure and policy changes that encourage active travel among children. *J Transp Health*. 2024;39:101932.
188. VicHealth. *Framing Walking and Bike Riding Message Guide*. VicHealth; 2021. https://www.vichealth.vic.gov.au/sites/default/files/VBM-Framing-Walking-Bike-framing—message-guide.pdf
189. Department of Transport. *Movement and place in Victoria*. 2019. Accessed 1 Nov, 2024. https://www.vic.gov.au/sites/default/files/2023-09/Movement-and-Place-in-Victoria-February-2019.PDF
190. Department of Transport and Main Roads. *Movement and Place Practitioner Guidance*. Queensland Government; 2024.
191. Theeuwes J, Godthelp H. Self-explaining roads. *Saf Sci*. 1995;19(2):217-225.
192. Theeuwes J, Snell J, Koning T, Bucker B. Self-Explaining Roads: Effects of road design on speed choice. *Transportation Research Part F: Traffic Psychology and Behaviour*. 2024;102:335-361.

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