Securing Australia's Future – Sustainable Urban Mobility

The public health impact of transportation decisions

CONSULTANCY SERVICES
21 October 2014

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PRIVATE & CONFIDENTIAL

Contents

1.0 INTRODUCTION

Effective and efficient transport systems are essential for the nation's social and economic wellbeing, competitiveness and community cohesion. Australia's transport system for the movement of people and goods comprises private vehicles, fleet vehicles, freight, public transport and non-motorised transport (cycling, walking). In comparison to other sectors of the economy, much of the system has a near-total dependence on a single form of energy—liquid fuels derived from petroleum sources. This dependence provides an opportunity to consider innovative alternatives, which look at optimising the system as a whole for both lower emissions and better public access to infrastructure in expanding cities.

The *Sustainable Urban Mobility* project aimed to synthesize cutting-edge research on alternatives, which look at optimising the transport system for lower emissions within and between innovative urban infrastructures, as well as improving health and safety outcomes. In particular, the project sought to examine effective ways to counter the institutional and cultural obstacles to transformational change. In the first phase, three separate studies were commissioned: a technological study; a social science study; and a public health study.

This report is the public health study. Its overall aim was to examine how the environment is being impacted included health and safety issues and innovative responses to these.

The specific questions the public health study was asked to address included:

- What are the health and safety impacts of existing Australian transport systems?
- What are the key barriers to improving urban transport related health and safety issues.
- How do different modes of transport compare? How do hours/day spent commuting impact on people?
- What are the implications of for health and safety in Australia of anticipated urban transport trends in the next 25 years?
- What are the implications of health and safety issues for future transport infrastructure developments?
- What are the implications of critical dependency on automobility (developed via the portability of oil and other fossil fuels) on health and safety? If other less flexible forms of transport are likely to become more prevalent, how will this impact health and safety?

- What steps can be taken in Australia to help transform Australia's transport and transport energy networks to become healthier and safer?

This report begins with a consideration of key trends that are related to considerations of health and wellbeing. It then goes on to consider how transportation choices affect public health, before examining what factors influence transportation choices. Based on these data, the report considers how well we are doing in Australia, before proposing a number of possible solutions. Finally it summarises the report's findings.

2.0 TRENDS

2.1 Population trends

For the first time in human history, 50% of the world's population live in cities and this is projected to increase to 70% by 2050.[1] The impact of urbanisation is amplified by rapid global population growth, with the world's population tipped to reach 9 billion people by the middle of this century. Governments across the globe are grappling with how to house, mobilize and feed a rapidly growing population.[2]

Approximately 90% of Australians already living in cities.[3, 4] However, consistent with global trends, our population is growing rapidly. Indeed, the Australian Bureau of Statistics' upper estimate for population growth in Australia suggests our population could almost double by 2050.[5] Two main approaches are being used to house Australia's growing urban population: lower density development on the urban fringe and higher density inner city development.[6] If not carefully implemented, both urban development approaches have the potential to produce negative health,[7-9] social[10] and environmental impacts.[11, 12] This report considers some of those impacts.

2.2 Ageing population trends

A major health challenge in the 21st century is the ageing population given the potential impact on health care and age-related services. However, there is now widespread agreement that many health problems associated with ageing - including the onset of frailty and disability[13, 14] - could be postponed or delayed if older adults increased their physical activity levels. Hence, sustainable transportation options that keep older adults as active as possible as they age – including walking, cycling and public transport use – are important health and wellbeing considerations for an ageing population.

While this may seem challenging in the current Australian context, we could learn from European experiences where, in some countries, a significant proportion of older adults use active modes of transport (see Figure 1). Pucher and Dikstra[15] found that while cycling was virtually non-existent in older adults in the United States, one quarter of all trips by older Dutch adults over 75 years were made by bicycle, as were 7% of German adults' trips. Similarly, 48% of all trips by German adults aged 75 years and older were walking trips, as were 24% of journeys made by Dutch adults in the same age-group. The authors concluded that these differences were not due to variations in physical and mental limits *per se*; rather it was due to differences in land use and transportation planning decisions. Contrary to Europe where the focus is on building compact cities, in North America (and Australia) walking and cycling trips are discouraged by longer trip distances caused by land use policies; the low cost car ownership and use; and public policies that facilitate driving and make "walking and cycling inconvenient, unpleasant; and, above all, unsafe" (p. 1511).

Decisions we make in the 25 years about how and where we house an ageing population could therefore have a profound impact on their mobility and transport choices; and ultimately on their health and wellbeing.

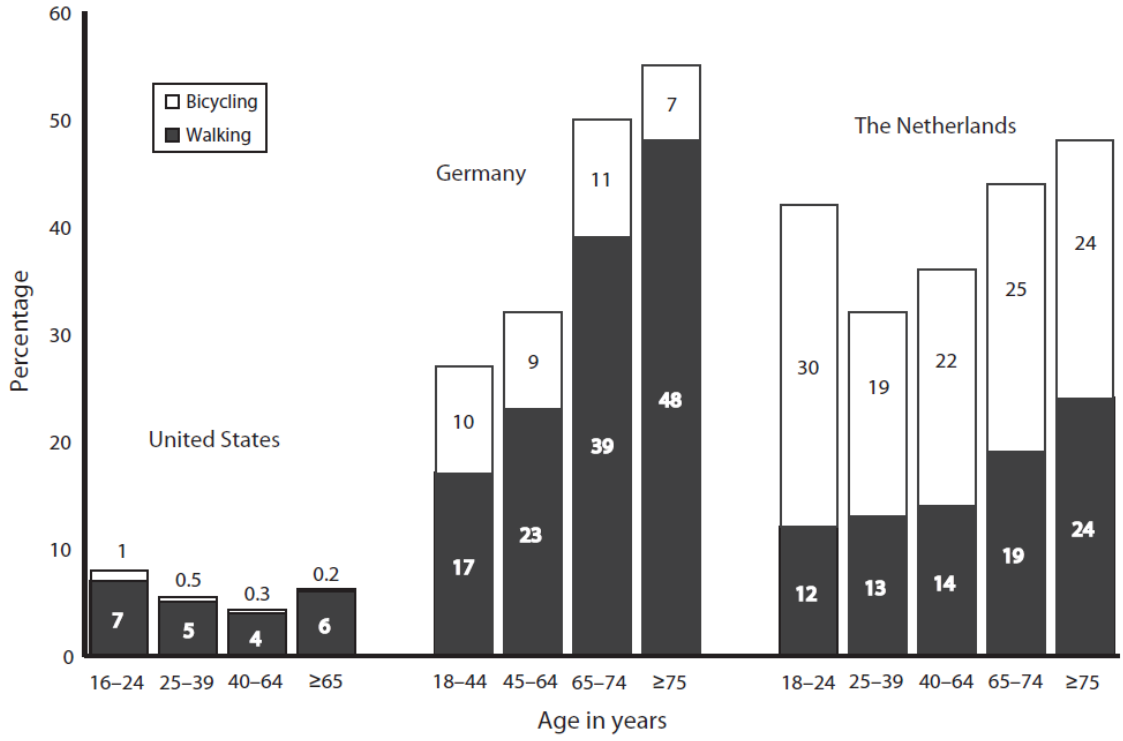


Figure 1: Percentage of walking and cycling trips by age group in the United States, Germany and The Netherlands 1995. Source:[15]

2.3 Health trends

2.3.1 Chronic diseases in Australia

Globally, the prevalence of chronic diseases is increasing. Currently some 36 million deaths annually are caused by chronic disease, [16] leading the United Nations to call high level global meetings to discuss the control chronic disease.

By international standards, Australians have very high life expectancies. However, consistent with global trends, there is a high prevalence of major chronic diseases - including cardiovascular disease, cancers, diabetes, dementia (see Figure 2) – which is a significant and growing social and economic burden.[17] While the prevalence of cardiovascular disease continues to fall, the Australian Institute of Health and Welfare[18] reports that the prevalence of preventable cancers is rising, the prevalence of diabetes has more than doubled in recent decades and mental health problems account for 24% of total years lost due to disability. Notably, two thirds of Australian adults and around one quarter of Australian children are either overweight or obese, which are risk factors for many chronic diseases. Hence, there is potential for further growth in chronic diseases in the next 25 years if we do not increase levels of physically active, and increases in weight are not curbed.

Notably, chronic disease patterns are spatially distributed with those in less wealthy suburbs, particularly those in low density suburbs on the urban fringe, more at risk than others.[19]

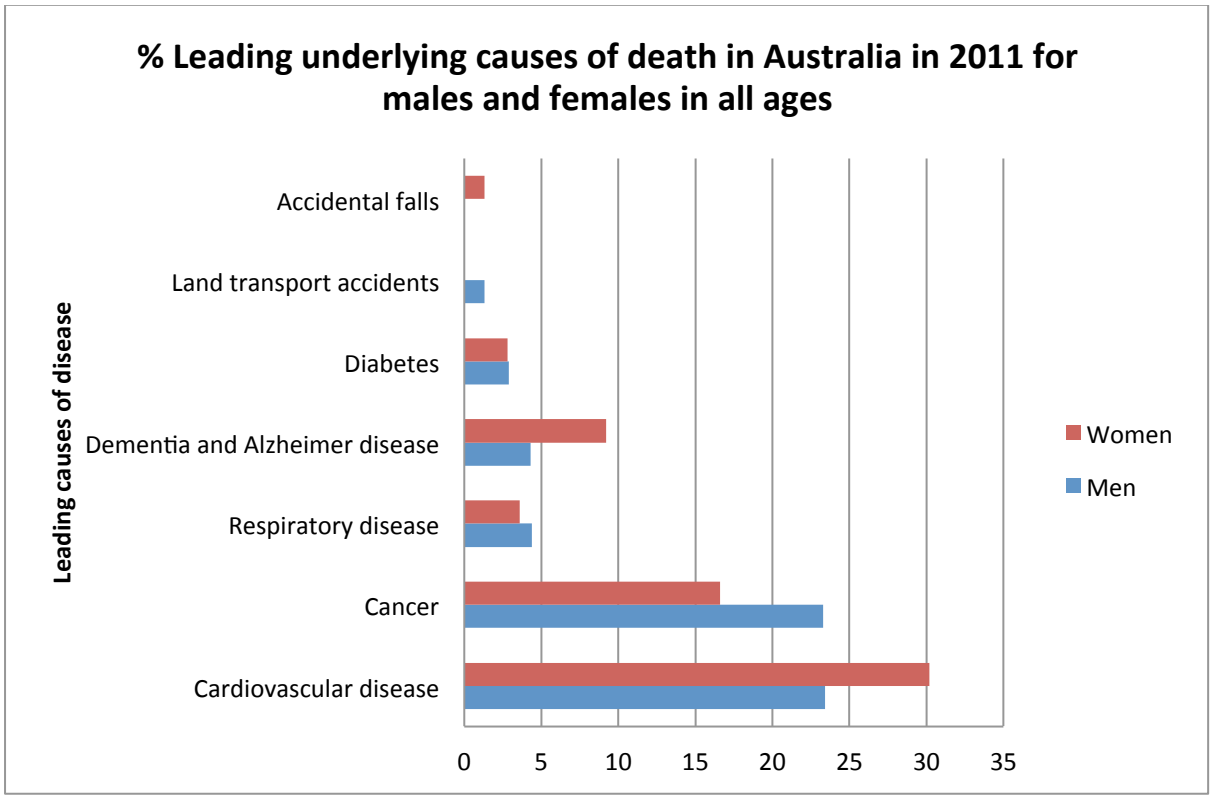


Figure 2: Leading causes of death in Australia (Source:[20])

2.3.2 Physical activity and sedentary behaviour

Importantly, most leading chronic diseases share common ***preventable*** lifestyle-related risk factors: one of which is directly related to transportation choices i.e., physical activity. In Australia, physical inactivity is the fifth leading contributor to the disease burden,[21] with almost 60 per cent of Australians aged 15 years or older being insufficiently active to benefit health.[17] However, another emerging chronic disease risk factor also related to transportation and land use decisions is sedentary behaviour including time spent driving.[22]

A recent global analysis of time use by Ng and Popkin[23] found that in the US, time spent in domestic, occupational physical activities and active travel had declined significantly since the late 1960s, while time spent in sedentary pursuits had increased (see Figure 3). Given the impact of physical inactivity and sedentary behaviour on weight gain and other cardiometabolic health risks, Ng and Popkin concluded that these trends represented "a major threat to global health", a finding that applies equally in Australia.

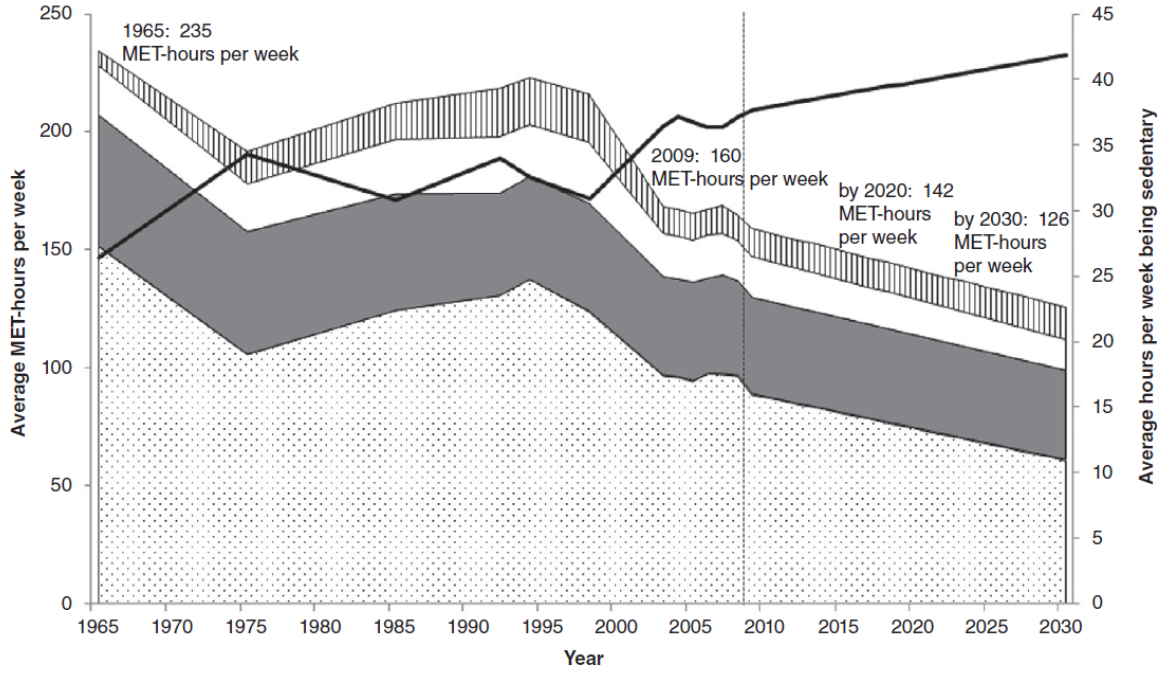


Figure 1 US adults metabolic equivalents of task (MET)-hours per week of all physical activity, and hours per week of time in sedentary behaviour: measured for 1965–2009, forecasted for 2010–2030.
Source: Multinational Time Use Studies (MTUS) v.5.52 (1965, 1975, 1998) and v.5.8 (1985, 1992, 1995), and American Time Use Survey 2003–2009; Applying Compendium of Physical Activity MET-intensity values based on reported time spent across 41 MTUS coded activities and by occupation. Forecasting for 2010–2030 based on 2003–2009 slopes.
active leisure PA, travel PA, domestic PA, occupational PA, sedentary time.

Figure 3: US Adults metabolic equivalents of task (MET)-hours per week of all physical activity, and hours per week of time in sedentary behaviour measured for 1965- 2009, forecast 2010 -2030 (Source: [23])

A large and consistent international body of scientific evidence demonstrates the health benefits of a physically active lifestyle.[16] The protective benefits of participation in regular physical activity, including active transportation include:

- 30% reduced risk of ischemic heart disease;
- 27% reduced risk of diabetes; and
- 21–25% reduced risk of breast cancer and colon cancer.[24]

In addition, regular physical activity reduces the risk of stroke and hypertension and is key to maintaining a healthy body weight.[24] In older adults regular physical activity improves both cognitive and physical function, reducing the risk of frailty and falls.[25]

Increasing physical activity levels will delay or postpone the development of chronic disease and is recognised as a priority in Australia and globally.[26]

2.4 Trends in the cost of chronic diseases

The annual costs of chronic disease and their risk factors are considerable and will continue to grow, particularly if increases in the prevalence of overweight and obesity, physical inactivity and sedentary behaviour are not curbed.[27-29] In 2008, Medibank Private estimated that the direct and indirect annual cost to the Australian economy of physical inactivity alone was around $13.8 billion.[30] In the same year, Access Economics estimated the financial and total disease burden cost of major chronic diseases related to physical inactivity and obesity: diabetes, cardiovascular disease, osteoarthritis and cancer (see Table 1).[27] It estimated the total direct and indirect cost of these diseases to be $325 billion, with the direct financial cost totalling $37.3 billion, nearly one quarter of which (i.e., $8.3 billion) was due to obesity (with a total cost of $58.3 billion). Of the financial costs of obesity, almost one half was born by government: 34.3% federal and 5.1% state governments.

Table 1: The financial and total burden of disease cost (billions $) of major chronic diseases

Cost	Diabetes		CVD		Osteoarthritis		Cancer	
	Total	**Obesity-related**	**Total**	**Obesity-related**	**Total**	**Obesity-related**	**Total**	**Obesity-related**
Financial	13.4	3.0	13.1	2.8	7.4	1.8	3.4	0.7
Burden of Disease	34.9	8.3	162.9	34.6	23.1	5.7	47.3	9.7
Total	48.3	11.3	176.0	37.4	30.5	7.5	*50.7*	10.4

2.5 Trends in injury

Traffic crashes are a major cause of injuries and deaths, particularly for younger people. Among young Australians aged 12-24 years of age, transport accidents are the most common cause of injury accounting for 44% of injury deaths and 30% of all deaths in 2005.[31] In the whole population, transport injuries resulted in 52,818 hospitalisations in 2009-10, representing 12.5% of all hospitalised injury cases.[17] Nevertheless, between 2008 and 2009, transport-related deaths fell from 1,524 to 1,477. The majority of these deaths (72% in 2009) were associated with motor vehicles driven on public roads. During the same

period, pedestrian deaths fell from 206 to 194, while the number of pedal cyclist deaths increased from 26 to 35.[32]

3.0 HOW DO TRANSPORTATION CHOICES AFFECT PUBLIC HEALTH?

There are a wide range of pathways through which transportation choices impact on health and wellbeing. A number of these hypothesized relationships are shown in Figure 4 and the evidence is now considered.

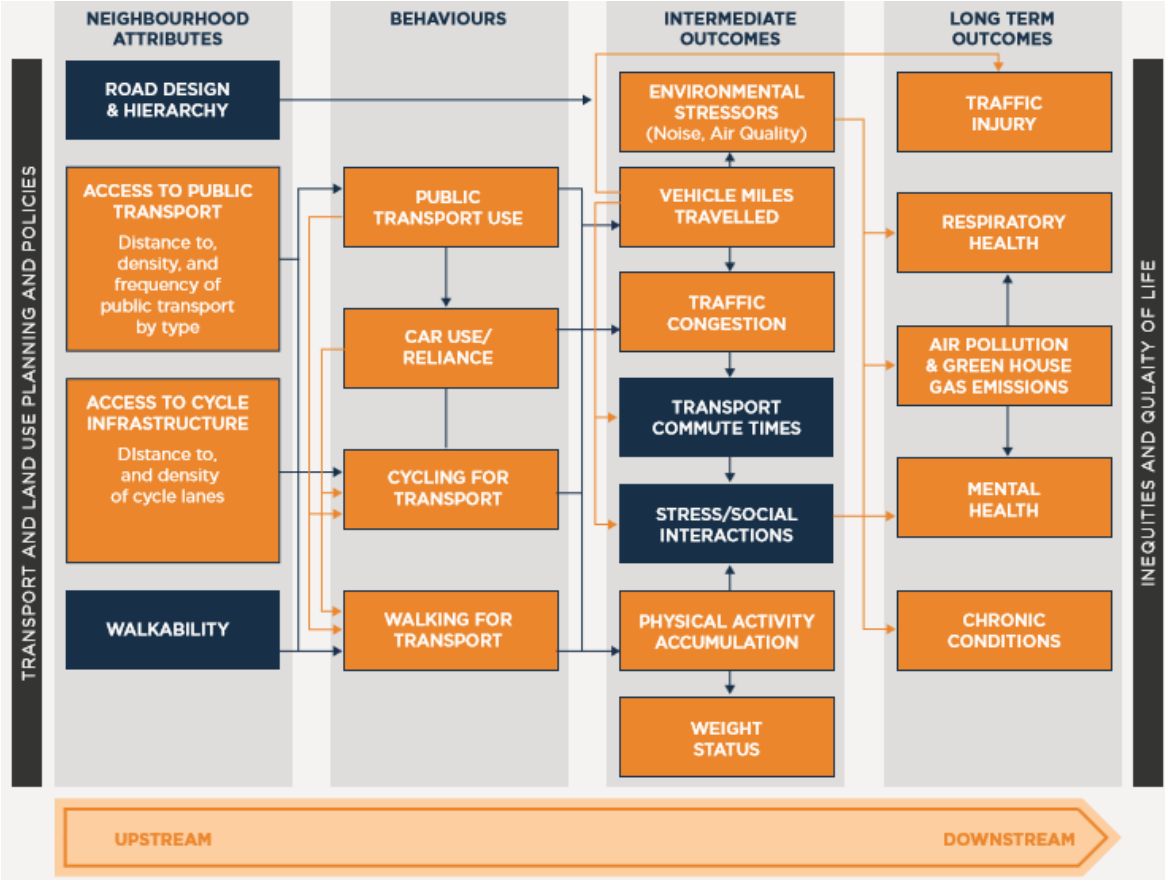


Figure 4: Hypothesized pathways through which transportation choices impact health and wellbeing. (Source: modified from [33])

3.1 Health benefits of active forms of transportation

As noted above, increasing levels of physical activity is a priority given that inactivity is a risk factor for many major chronic diseases. Globally, increasing active forms of transportation has been identified as one means of increasing physical activity, with co-benefits across multiple sectors.[34-37] Active transport

includes any form of human powered transportation (e.g., on foot, by bicycle, skateboard etc). In the health sector, public transport is often included as a form of active transport because public transport trips generally involve walking or cycling to and from stations or stops.[36]

The potential health benefits of active transport are significant. A meta-analysis of eight studies concluded that engaging in active transport had a significant protective effect against cardiovascular risk.[38] Similarly, a meta-analysis of 22 cohort studies of adults[39] found that compared with no physical activity, 2.5 hours/week of moderate intensity activity (equivalent to 30 min daily on 5 days a week) was associated with a 19% reduction in mortality risk, and 7 hours/week of physical activity (i.e., one hour daily) with a 24% reduced mortality risk. A smaller effect was observed in studies that looked at walking alone, suggesting that a combination of activities, some of which are more intense (e.g., cycling) may be required to maximise the benefits of physical activity. However, those who walked 2.5 hours/week had an 11% reduced risk of mortality. The evidence for cycling itself was inconclusive due to the quality of studies. However, the authors concluded that given that cycling is generally more vigorous that walking,[40] one could expect that the health benefits of cycling are comparable with moderate physical activity i.e., 19% reduction in mortality for 2.5 hours/week and 24% for one hour daily. **This suggests that if active forms of transportation could be increased, it could positively impact on chronic disease risk factor profiles**.

There are fewer studies on the health benefits of active transport modes for children. A British study found that children who walked or cycled to school were fitter than those who travelled by bus or car, with the likelihood of being fit 30% higher in boys who cycled and sevenfold higher in girls.[41] Conversely, a Western Australian study[42] found that after adjustment for potential confounders, children driven to school recorded fewer weekday steps than those who walked and participated in fewer active leisure activities (girls only). These researchers concluded that encouraging children, especially girls, to walk to and from school (even for part of the way for those living further distances) could protect the health and well-being of those children who are insufficiently active.

Despite the health benefits of active transport to schools, over the last three decades, children's active forms of transportation have rapidly declined in most developed countries,[43-47] (see Figure 5). Australian studies suggest that only around 20% of secondary students, and between 35-39% of primary school children, now use active modes of transport to school.[48]

Figure 5: Time trends in the percentage of children and young people who use active transport to and/or from school. (Source:[48])

There are a number of reasons for the low levels of active transportation to schools. Key drivers of parent decision-making are concerns about traffic safety and lack of supportive infrastructure such as safe crossings and personal safety.[49] From a practical perspective, distance to destinations and the need to cross heavily trafficked roads are contributing factors.[49] For example, education department policies to increase school sizes are contributing to the distances between homes and schools.[50] A US study estimated that only one-half or fewer children from elementary to high school now lived within a 'safe and reasonable' walking distance from their school (defined as within 1.6 km of the school along the street network and on streets with traffic speeds ≤40 km/hour.[51] Another US study found that increasing distances between homes and school accounted for about one half of the decline in active forms of transport to school.[52] Nevertheless, while important, another study found that only a fraction of US children who live within 1.6 km of school now commute using active modes,[53] suggesting other factors drive parents' decisions to allow their children to walk. Parental concerns about traffic safety are clearly important. For example, a Western Australian study found that children who lived in neighbourhoods with both low traffic and high street connectivity were three times as likely as others to walk to school.[49] **Urban policy and transport planning decisions – including the size of schools, and the design of neighbourhoods and the movement networks surrounding schools –may contribute to children being permitted and able to walk to school**.

Given the potential health benefits, transportation and urban design interventions that encourage active transport are increasingly seen as important mechanisms for promoting physical activity and health.

3.2 Obesity levels and transportation mode choice

As outlined earlier, in recent decades there has been a rapid increase in sedentary activities, and time spent in active pursuits has declined. While there are limitations associated with 'ecological' data that cannot establish causation, Figure 6 presents multi-country data correlating obesity levels with the proportion of total trips that are made by walking, cycling or public transport.[54] As can be seen, the prevalence of obesity is considerably higher in countries such as Australia, where motor vehicle travel dominates.

A study in the US[55] found that for every 60 minutes spent travelling by motor vehicle, the odds of obesity increased by around 6%. Similarly, a small number of Australian studies have also explored the relationship between car travel and obesity. In Sydney, Wen and colleagues[56] found that people who drove to work were less likely to achieve recommended levels of physical activity, and 13% more likely to be overweight or obese than those who used active modes. Similarly, in a longitudinal study in South Australia, Sugiyama et al[57] found that over a four year period, those who commuted daily by motor vehicle tended to gain more weight than those who commuted by alternative modes.

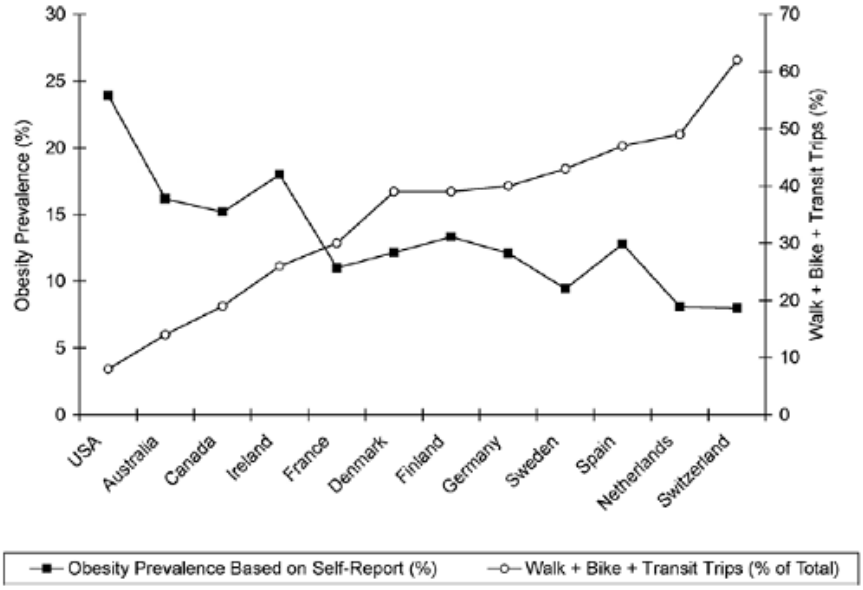


Figure 6: Obesity (BMI 30 kg/m^2) prevalence and rates of active transportation (defined as the combined percentage of trips taken by walking, bicycling, and public transit) in countries in Europe, North America, and Australia. (Source:[54])

While numerous complex factors have converged to cause the global obesity epidemic, there is widespread agreement that a contributing factor is declines in active forms of transportation – walking, cycling and public transport trips.

3.3 Traffic injury

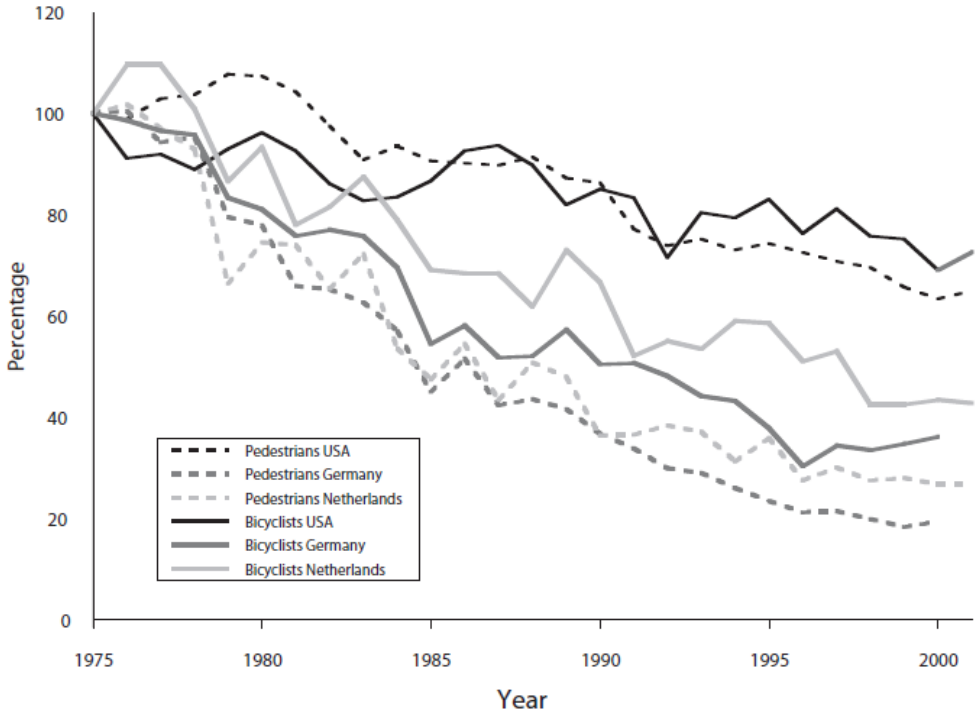
Speed is a major factor contributing to traffic fatalities.[32] However, studies consistently show an inverse relationship between levels of density and road traffic mortality.[58-60] Compared with compact areas, more time is spent in vehicles and more vehicle kilometres are travelled in low density sprawling metropolitan areas. In denser areas, trip distances are shorter and there is a greater reliance on walking and public transport. A study of US cities that found lower automobile fatality rates (excluding pedestrians) in denser cities compared with sprawling cities.[61] It is plausible that in higher density neighbourhoods trips are shorter and traffic travels at slower speeds.

Nevertheless, a number of neighbourhood features appear to increase the risk of pedestrian injuries, particularly for children, including:

- high traffic speeds and volumes;
- high density of curb parking;
- the number of streets crossed during routine travel;
- the absence of a park or play area near home;

- the presence of cross walks where there are no traffic lights present; and
- dwelling or population density.[61]

Thus, to reduce the risk of crash injury and fatalities, safe pedestrian and cycling environments are required. An international comparison of American and European countries found that American pedestrians and cyclists were more likely to be killed or injured on a per-trip or per-kilometre basis than those in The Netherlands or Germany where walking and cycling is more prevalent.[15] The authors argued that this was no accident. Rather they noted that over a 25 year period both The Netherlands and Germany had invested in a comprehensive range of strategies covering infrastructure, policy and education including: walking and cycling infrastructure, traffic calming in residential areas, urban design that is supportive of active transport modes, restricting motor vehicle use in cities, strict enforcement of regulations to protect cyclists and pedestrians and traffic education for both motorists and non-motorists.[15] The results of this investment have been a rapid decline in pedestrian and cycling injuries (see Figure 7).



Source. US Department of Transportation[12]; German Federal Statistical Office[17]; German Federal Traffic Institute[18]; Statistics Netherlands[19]; and Dutch Ministry for Transport, Public Works and Water Management.[20]

Figure 7: Trends in pedestrian and bicycling fatalities in the United States, Germany and the Netherlands, 1975-2001 (1975 = 100%)

3.4 Transport noise

Noise can affect physical and mental health by causing annoyance and/or sleep deprivation.[62] While acute exposure to environmental stressors such as noise can be acutely stressful, continual exposure can result in chronic stress, with important health implications.[63] However, the impact of noise on mental health is complex. For example, the effects of noise on individuals varies, depending upon an individual's level of sensitivity, and how they attribute or appraise the meaning of the sound.[63] For example, noise from neighbours may be perceived as more 'annoying and intrusive' than objectively louder impersonal non-human sounds such as the sound of a train or traffic.

A review by Evans, Wells and Moch[64] found that most studies on the impact of noise and mental health relate to airport noise. These reviewers observed that many early studies supporting a relationship between airport noise exposure and elevated psychiatric admissions were cross sectional and failed to adjust for socioeconomic status of participants. Nevertheless, they concluded there was sufficient evidence to suggest that exposure to airport noise reduced psychological wellbeing. However, a more recent narrative review [62] concluded that there was now convincing evidence of mental health impacts of transport noise (from both airports and roads), including reduced quality of life and wellbeing; and impaired child cognition measure through reading comprehension and memory skills. Yet, the authors concluded that transport noise was not associated with serious psychological ill-health for children or adults.

Traffic noise exposure may also impact residents' physical health outcomes. Clark and colleagues [62] review reported a small but significant effect on cardiovascular disease and hypertension. Similarly, a longitudinal study of older adults in mega-city Tokyo found that men (but not women) who reported no trouble with traffic noise lived longer than others.[65] Furthermore, living within 200m of a busy road appears to be a risk factor for admission to hospital due to any cause.[66]

Thus, there is some evidence reducing exposure to transport noise enhances quality of life, and may also benefit physical and mental health outcomes. Notably, the impact of noise on health is partly related to the location of housing and other key services such as schools (e.g. located on heavily trafficked roads or near an airport), as well as its construction and insulation, which can affect the amount of noise transfer from the outdoor environment. **Hence, the mental and physical health impacts of traffic-related noise could be partly managed through appropriate design of housing i.e., bedrooms away from the noise source; and housing located near to external noise sources achieving appropriate levels of sound attenuation**.

3.5 Transport-related air pollution and respiratory health

Conventional motor transportation reduces air quality and contributes to the risk of respiratory diseases (e.g., asthma).[61, 67]. The 2010 Global Burden of Disease Study[68] estimates that lead exposure, mainly from transport, accounted for 13.9 million disability life adjusted years (DALYs) globally. In Australia, 1% of the burden of disease and injury is attributed to urban air pollution, with 62% of this burden being due to cardiovascular disease, and the burden increasing with age.[69]

The relationship between traffic exposure and poor respiratory health is well documented. Urban air pollution concentrates near major heavily trafficked and congested transport arteries.[70] Evidence shows that people living on or near busy roads (i.e. within 300m) are exposed to significantly higher levels of pollutants, including particulate matter, carbon monoxide and nitrogen oxide (NO).[71, 72] However, urban air pollution varies by location, with particulate matter accumulating at traffic lights, where vehicles idle.

Numerous meta-analyses report a relationship between air pollution exposure and various health impacts including asthma onset in childhood;[73] asthma exacerbation;[73, 74] non-asthmatic respiratory symptoms;[73] impaired lung function;[73, 75, 76] cardiovascular mortality and morbidity;[73, 75, 77] all-cause mortality;[74, 75] hospital admissions;[75] and restricted physical activity.[75] Moreover, associations are seen even at the relatively low pollution levels observed in Australia.[78, 79]

The American Thoracic Society [80] concluded that exposure to air pollution is associated with a number of conditions, ranging from severe illness to minor irritations:

- increased mortality and incidence of cancer;
- worsening of disease in people with existing cardiopulmonary illness;
- increased incidence of asthmatic attacks, lower and upper respiratory tract infections that may or may not interfere with normal activity;
- decreased lung function as assessed by forced expiratory volume in one second (FEV1) and/or FVC;
- increased prevalence of wheezing and chest tightness and cough and/or phlegm requiring medical attention; and
- eye, nose and throat irritations that may interfere with normal activity if severe.

Urban design and transport interventions that reduce motor vehicle emissions and traffic, and which locate homes and schools away from major roads with heavy traffic can have benefits for respiratory health.

3.7 Transportation, climate change and health

By reducing greenhouse gas (GHG) emissions, increasing active and sustainable transport can contribute to mitigating climate change, with benefits for both the environment and human health. Australia's per capita CO2 emissions are nearly twice the OECD average, making us one of the world's highest emitters per population. [81, 82] Transport currently contributes 14% of Australia's GHG emissions, with passenger cars being the largest source of transport emissions.[81] There are also significant emissions entailed in the wider car and transport industry, including in fuel extraction, processing and distribution, vehicle manufacture and road construction and maintenance.[83, 84]

Climate change caused by anthropogenic greenhouse gas (GHG) emissions is already having, and will increasingly have, serious negative impacts on global human health.[85] In Australia, climatic warming has already led to an increase in the ratio of summer to winter mortality.[86] Future health impacts are predicted to be extensive in Australia, including increased deaths, illness and mental health problems from more frequent extreme weather events, an increase in allergenic pollens and air pollutants which cause respiratory illness, an increase in the range and seasonality of mosquito-borne infections, fresh water and food shortages, and an increase in food and water-borne diseases.[86-91] Disadvantaged groups, such as remote Aboriginal communities and people on low incomes are likely to be at higher risk of these health effects, and to have less capacity to respond, leading to increased health inequalities.[86, 89]

Thus there are immediate health and environmental imperatives to reduce global GHG emissions. Widespread substitution of car use with active travel could significantly reduce Australia's GHG emissions, thus contributing to the global effort to mitigate climate change. **A range of studies have explored the health co-benefits generated by shifting towards active transport, through reduced GHG emissions, increased physical activity and prevention of obesity.[92-96]** For example, a US study calculated that replacing short car trips with walking or cycling would significantly reduce US GHG emissions, and almost eliminate obesity in the absence of dietary change.[94] **In contrast, other transport policies to reduce GHG emissions, such as more fuel-efficient cars or other personal motorised vehicles are unlikely to have significant benefits for physical activity levels or obesity.**

3.8 Transportation as a social determinant of health

Access to a multi-modal transportation system is a social determinant of health,[12, 33] which facilitates access to other underlying health determinants, particularly a distributed labour market, education, food,

health and social services, as well as opportunities to recreate and socialise. Transportation infrastructure – including access to public transport, footpaths, controlled crossings, cycle paths, and connected street networks – which links to shops and services, is an essential components of a liveable community, without which residents are disadvantaged and can become socially isolated.[97]

Land use and transport planning decisions determine access to a multi-modal transportation system. If not managed well, this can lead to transport poverty,[98] which poses considerable threats to the health and wellbeing of residents, and creates health inequities. Transport poverty occurs when individuals are forced into transport options which are more expensive than they can reasonably afford. As discussed below, the impact of transport poverty is tightly coupled with the impact of rising living costs including mortgage stress and rises in inflation and costs of utilities.

4.0 WHAT KEY FACTORS INFLUENCE TRANSPORTATION CHOICES?

There is consistent evidence that neighbourhood design and levels of active transport, particularly walking.[99] Higher residential densities, good street connectivity based on grid networks, mixed land use and high-quality active transport infrastructure are associated with higher levels of walking and cycling for transport. This type of urban form creates shorter and more convenient walking and cycling routes between homes and jobs, retail and essential infrastructure and services.[100-102] The literature also indicates that shorter distances to public transport stops are associated with higher levels of walking, especially among people on lower incomes who are more reliant on public transportation.[103] Furthermore, having accessible and attractive public open space and recreation facilities is associated with higher levels of recreational physical activity, particularly walking.[100, 101]

Hence, although most of the evidence is cross-sectional, there is widespread recognition that land use and transportation planning decisions contribute to individual transportation choices. Ewing and Cervero[104] have helpfully distilled these into the 6Ds: Design (of the movement network including street connectivity, block lengths and access to walking and cycling infrastructure); Diversity (accessed to mixed use planning and a mix of housing types; job/residential ratios); Density (levels of housing and job density); Destination access (time spent commuting to work by car, time spent commuting to work by transit; distance to shops and services); Distance to public transport (access and frequency of services); and Demand Management (the amount of parking). However, the use of a multi-modal system is also influenced by two further Ds: Demographics (the age, gender and socioeconomic status of residents); and

Desirability (i.e., real and perceived safety; a high public realm [105] and attitudes towards using active modes).

There are very few longitudinal studies (i.e., those measuring the same people multiple times) examining the impact of land use decisions on transportation choices. Western Australian research followed people who had relocated and found that after taking into account residential preferences, those who gained access to different types of local destinations (e.g., a shop, newsagent, post-box, supermarket, public transport) walked 5.8 minutes for each type of destination that they gained after relocating.[106] Living in a neighbourhood with a mix of different types of land uses was found to be a major contributor to whether or not people walked locally.[107] Similarly, a US study of people changing residential locations, found that relocating to a neighbourhood with a 10-point higher Walk Score resulted in a significant increase in transport walking, a 11% higher odds of meeting public health walking goals and a modest reduction in body mass index.[108]

While these relationships are not straight forward, decisions about the way we build cities impact the ability and willingness of individuals to use alternative modes of transport. (Re)designing cities to support active modes of transport would therefore have co-benefits across multiple portfolios: health, environment, and transport.[109]

5.0 HOW WELL ARE WE DOING?

5.1 Household travel surveys

Understanding transport planning and transport mode choices in Australian cities requires data on travel patterns; i.e. how many people are moving around cities, and where and how they are moving. Although measuring travel patterns is complex and surveys vary, a number of major cities in Australia have developed a household travel survey to provide a comprehensive understanding of how, where and why people are travelling within cities.

5.1.1 Purpose of travel

Results from household travel surveys collected in five capital cities across Australia (see Table 2) show that the three main reasons for travel are to fulfil daily requirements: social and recreation purposes, shopping and commuting. Notably, work-related trips comprise only between 18-32% of total trips across these Australian cities.

Table 2: Trip purpose for all trips across selected Australian Capital Cities – Weekdays only (%)

Purpose of Travel	Sydney [1]	Melbourne [2]	Perth [3]	Brisbane [4]	Hobart [5]
Work / Commuting	23	21	18	27	32
Shopping	16	19	20	26	22
Social and Recreation	24	22	34	14	19
Education/Childcare	9	7	9	11	8
Personal Business	6	9	4	NC	9
Serve passenger /accompany others	18	20	9	23	9
Other	3	2	-	-	1

Source:
1. Household Travel Survey (HTS 2011/12) Summary Report Release.
2. Department of Transport (2007) Victorian Integrated Travel Survey (VISTA).
3. Social Data Australia (2000) Potential Analysis Perth
4. The State of Queensland (Department of Transport and Main Roads) (2012)
5. The State of Tasmania (Department of Infrastructure, Energy and Resources) (2010)

5.1.2 Transport mode

The vast majority of trips in Australian cities are made by motor vehicle, with car transport (either as a driver or passenger) accounting for around 70-80% of trips, depending on the city. Walking trips range from 10% in Brisbane to 20% in Hobart, while public transport trips range from 4% in Hobart to 11% in

Sydney. Cycling trips make up a very small proportion of total trips, ranging from only 0.9% in Hobart to 2% in Melbourne and Perth (see Table 3). Clearly there is enormous scope to increase both walking and cycling.

Table 3: Mode share across selected Australian capital cities – Weekdays only (%)

Mode of Transport	Sydney[1]	Melbourne[2]	Perth[3]	Brisbane[4]	Hobart[5]
Car as Driver	47	54	60	56	55
Vehicle passenger	21	24	20	23	19
Walk	18	12	12	10	20
Bicycle	NC	2	2	1	1
Public Transport	11	7	6	10	4
Other	2	1	0	0	0

NC = Not Captured

Source
1. Household Travel Survey (HTS 2011/12) Summary Report Release.
2. Department of Transport (2009) Victorian Integrated Travel Survey (VISTA).
3. Social Data Australia (2000) Potential Analysis Perth
4. The State of Queensland (Department of Transport and Main Roads) (2012)
5. The State of Tasmania (Department of Infrastructure, Energy and Resources) (2010)

5.1.3 Distance travelled

Motor vehicle transport dominates Australian cities, despite the fact that a large proportion of trips are short trips: overall more than one in six adults drives less than 5km to work or study on a daily basis.[105] This suggests that trips by other modes are potentially feasible, if the 6Ds – including demand management, were addressed.

Table 4: Average Trip length

Distance	Sydney [1]	Melbourne [2]	Perth [3]	Brisbane [4]	Hobart[5]
Average Trip Length (Km)	8.7	10.2	NA	9.1	9.1

Source
1. Household Travel Survey (HTS 2011/12) Summary Report Release.
2. Department of Transport (2009) Victorian Integrated Travel Survey (VISTA).
3. Social Data Australia (2000) Potential Analysis Perth
4. The State of Queensland (Department of Transport and Main Roads) (2012)
5. The State of Tasmania (Department of Infrastructure, Energy and Resources) (2010)

A large number of short trips are made by car, and these have potential for conversion to an active mode. Nevertheless, longer distances between homes and transport destinations create greater car dependency, which has implications for transport poverty, as discussed below.

5.2 Transport poverty

In Australia's major cities, an increasing number of people are living further away from central business districts and activity centres. This problem is compounded by jobs re-centralising into city centres.[110] Together this increases distances between where people live and where they need to travel for work, shopping, socialising and recreating.

As noted earlier, low density housing continues to be built on the urban fringe of Australian cities. Fringe developments are typically characterised by low housing and employment density, limited (if any) mixed use development, poor access to public transport and often with poorly connected street networks and 'big box' shopping developments. Thus, in these car dependent neighbourhoods with few other transport options, residents are at risk of 'transport poverty', particularly if they do not own a motor vehicle or struggle to afford auto-related transport costs.

Murray and Davis (2001), provide the following diagram (Figure 8) which captures the elements creating transport poverty in some areas. The figure highlights the nexus between dispersed social and recreation services, work locations, healthcare, inadequate public transport and reduced housing options in these areas. Together these factors have profound health and wellbeing consequences for residents of these areas. Should they not be able to drive, they are at particular risk of social isolation, although known to be associated with premature death and poor mental health outcomes.[111-113]

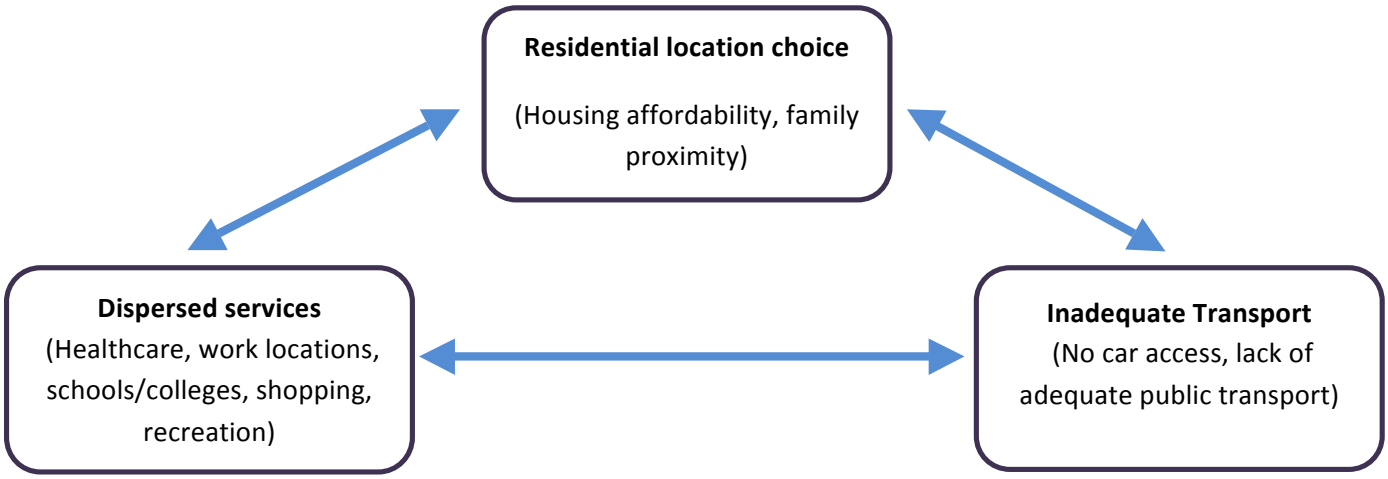


Figure 8: Elements creating transport disadvantage. Source: [114] based on [115]

5.3 Walkability

There are a variety of reasons for whether people choose walking as a means of transport. However, as noted above, this includes the ability of residents to walk locally, which depends on neighbourhood design. A walkable neighbourhood have higher levels of population density, with connected street networks and local destinations.

There are now well-established methods for measuring the 'walkability' of communities, incorporating measures of housing density, mixed land use and street connectivity.[11, 67, 104, 116-121] For example, to assess levels of walkability for transport, researchers at the University of Melbourne's McCaughey VicHealth Centre for Community Wellbeing applied a 'transport walkability index' across greater Melbourne. Areas with well-connected street networks, a variety of local destinations (e.g., local jobs, shops, services, and public transport infrastructure) and higher housing density score higher on this transport walkability index. In contrast sprawling areas with cul-de-sacs, low levels of housing density and few local destinations receive a lower score. As can be seen in Figure 9, inner Melbourne is generally shown in shades of green indicating much higher levels of walkability. Melbourne's outer areas generally have much lower levels of walkability as shown in shades of yellow through to dark red. Consistent with a growing body of evidence, one would expect that compared with high walkable areas in inner Melbourne, the likelihood of residents walking and using public transport will be lower in medium to low walkable areas, while the odds of obesity and vehicle miles travelled would be higher.

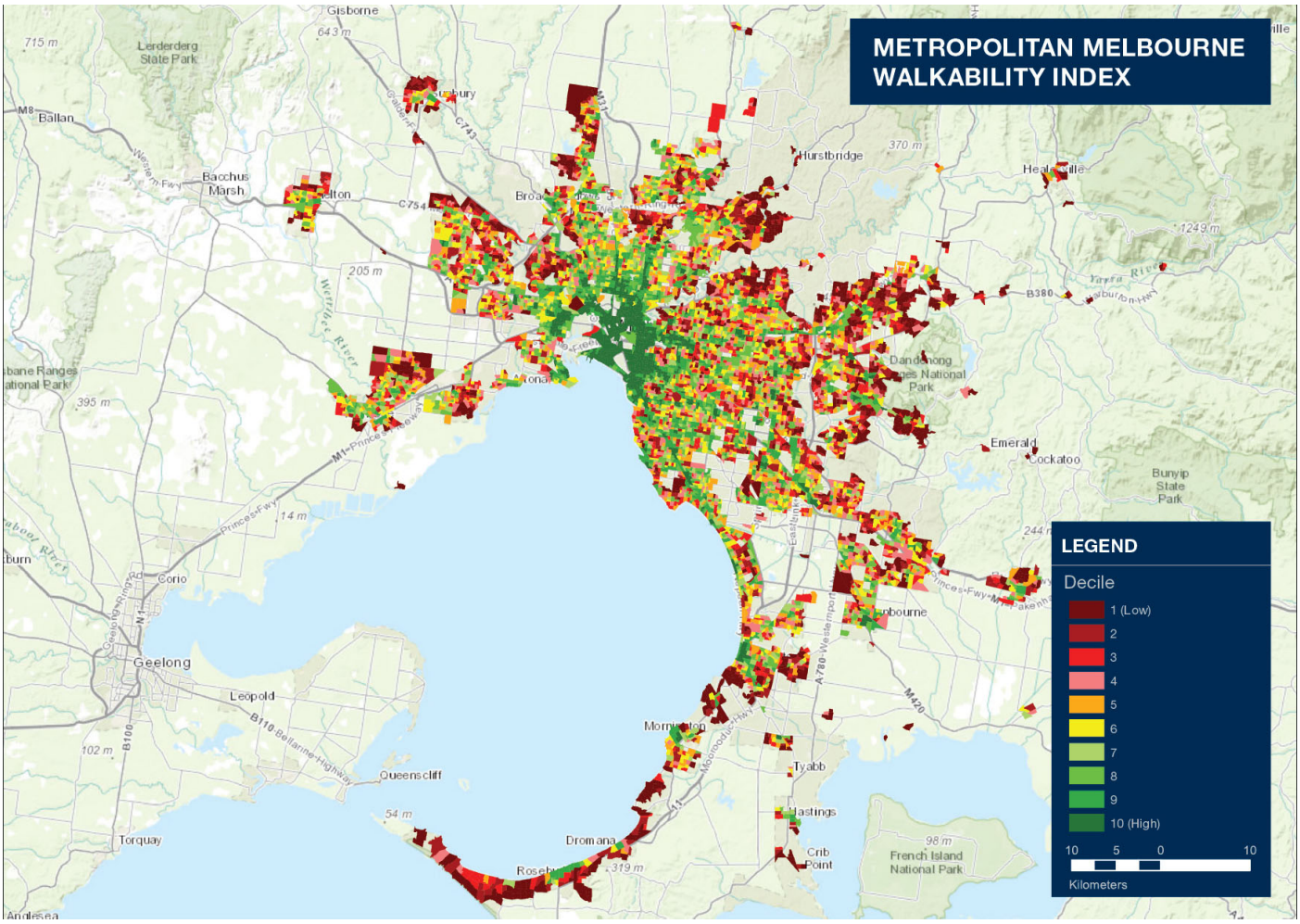


Figure 9: Metropolitan Melbourne Region walkability index (Source122)

5.4 Access to cycling infrastructure

Communities Indicator Victoria at the McCaughey VicHealth Centre for Community Wellbeing provides local-government level data on factors that influence community wellbeing. One such indicator is access to the Principal Bicycle Network (PBN) within 400m of resident's homes. As can be seen in Figure 10, inner Melbourne is generally shown in shades of green indicating much higher levels access to the principal bicycle network. Melbourne's outer areas, on the other hand, generally have poor access to the PBN as indicated by shades of yellow through to dark red.

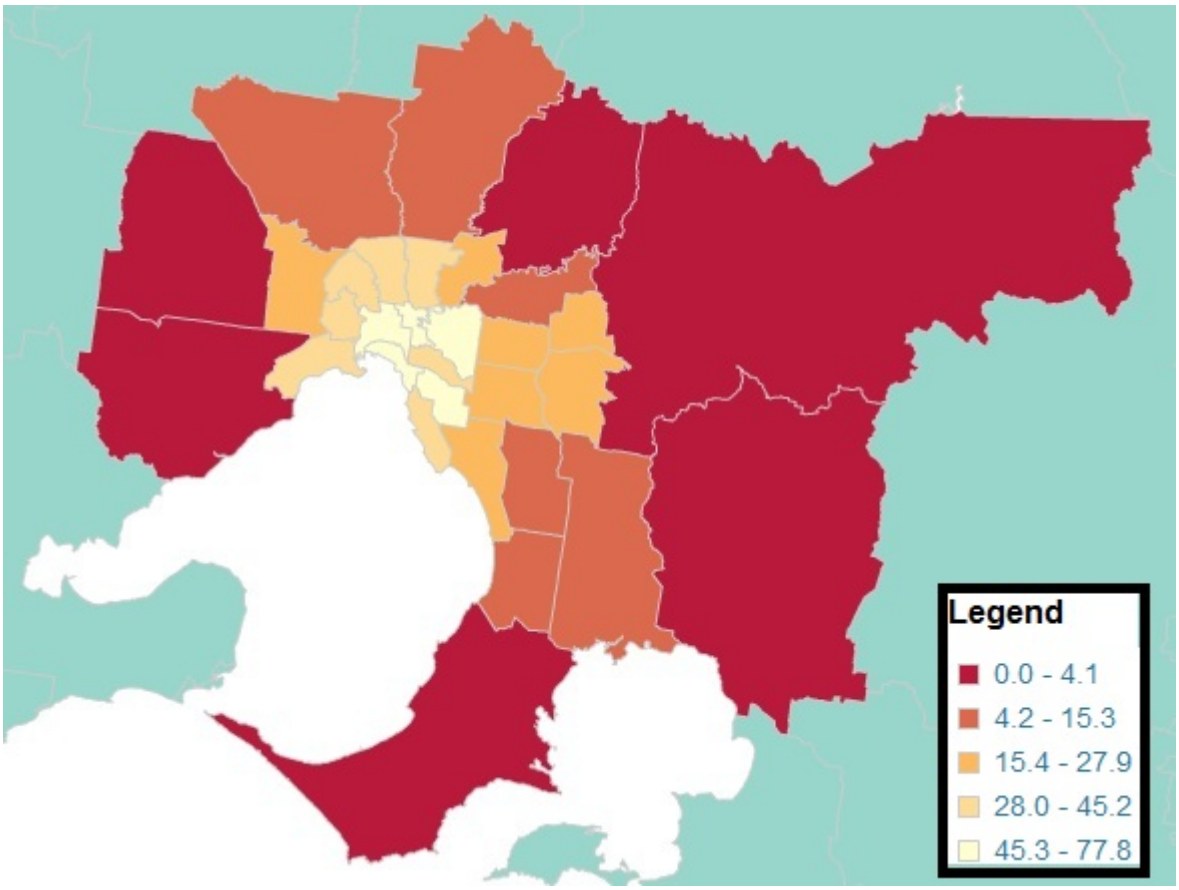
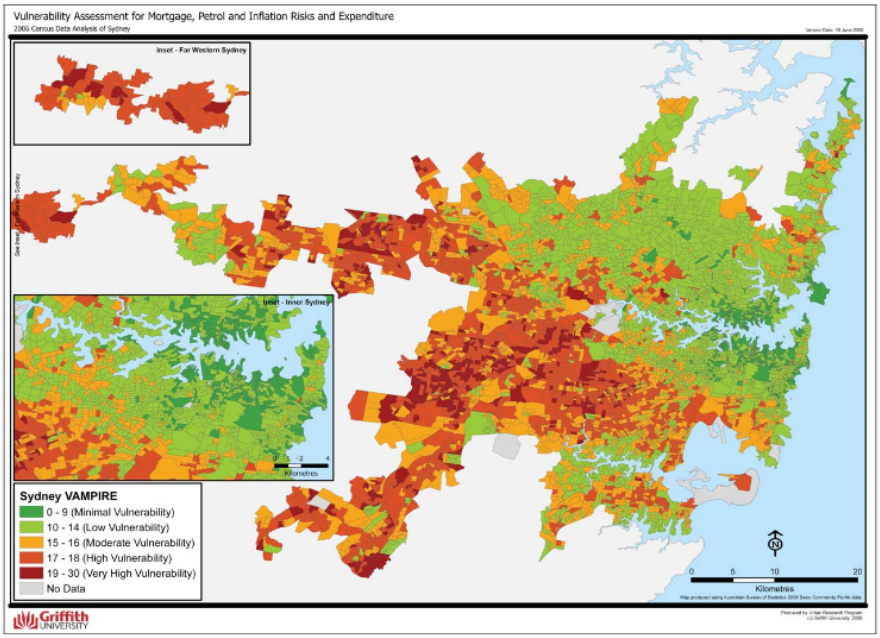
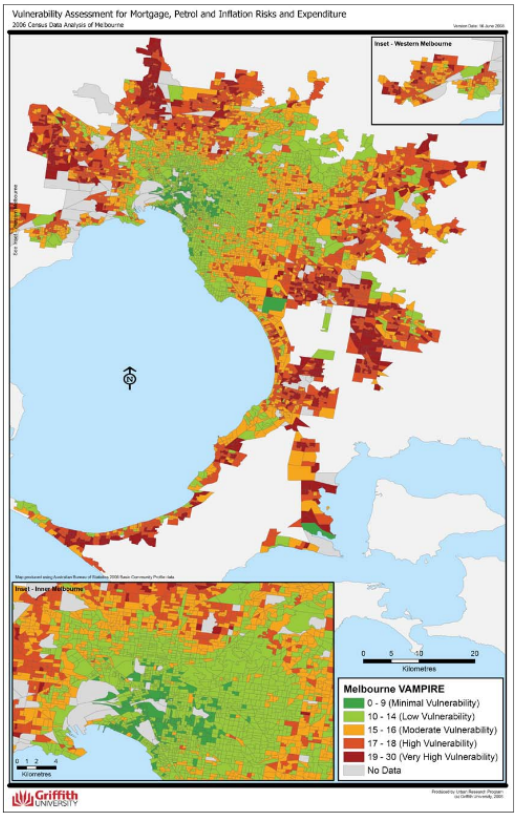


Figure 10: Proportion of LGA within 400m of the Existing PBN (% of total area of LGA).

5.5 Access to public transport

Dodson and Sipe[98, 123] have examined access to public transport across Australian cities (see Figure 11 for Perth, Melbourne and Sydney). They found that residents of outer suburban developments were vulnerable to mortgage and oil stress should fuel prices rise given they have very poor access to public transport.





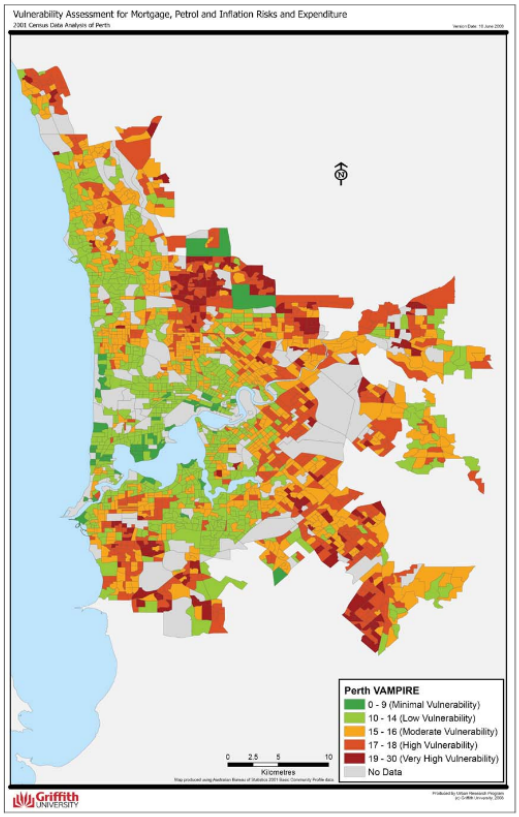


Figure 11: Oil and mortgage vulnerability in Sydney, Melbourne and Perth 2006 (Source: Dodson and Sipe[98, 123])

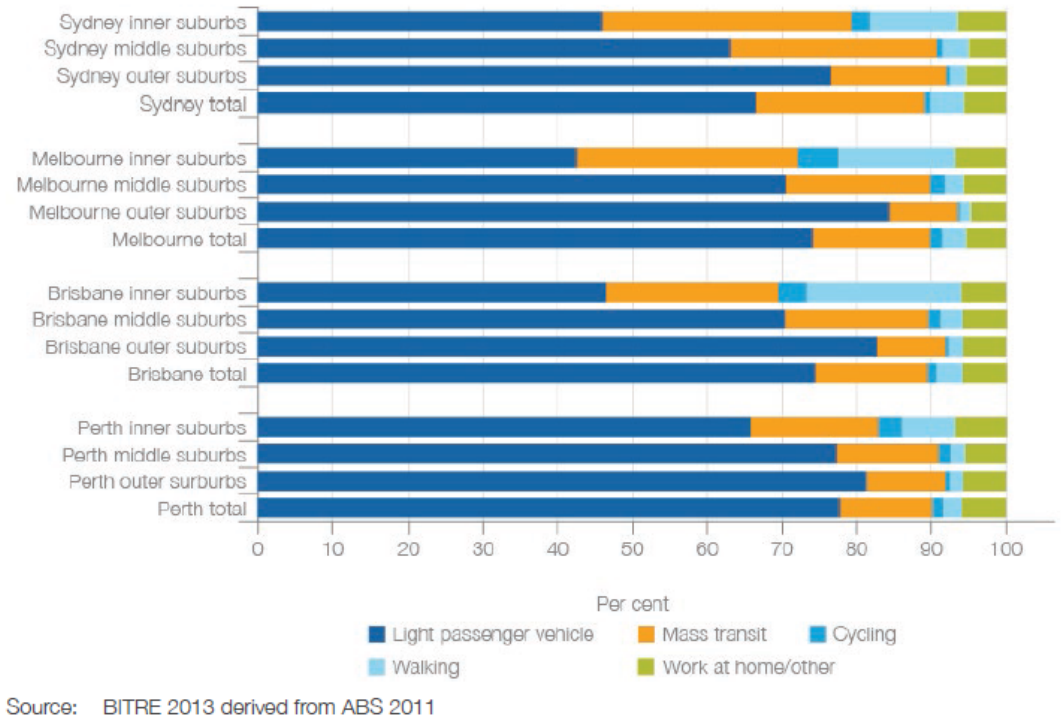
6.0 POTENTIAL SOLUTIONS

If Australia's major cities are to optimise health outcomes while meeting the future demands of mobilising a growing (and ageing) population, sustainable transportation options that prioritise walking, cycling, and public transport over low emission vehicles.[96] Critically, to make this possible, it will be necessary to incorporate healthy active design principles into city planning and management. As highlighted in this report, city and community design either facilitates or discourages active modes of transport.[124]. However, the co-benefits of prioritising walking, cycling and public transport use is widely acknowledged globally. In 2009, the UK Chief Medical Office called for the health sector to actively encourage daily transport-related walking and cycling as both a health and a climate-change mitigation strategy.[125] The OECD has also called for leadership from 'transport, land use *and* health ministers' to facilitate action to encourage active forms of transport.[126] Moreover, creating compact health-enhancing cities is now a global priority [127] This signals high-level international support for integration of urban planning and public health in city planning.

Clearly cities need to continue to evolve and develop; however they need to do so while creating greater opportunities for active transport mode choices: walking, cycling and public transport. This will require integrated land use and transportation planning.

6.1 Improving active transport connections between homes and destinations

As outlined in the State of Australian Cities Report[110] one way to improve the design of our cities is to improve connections between where people live and the destinations they need to travel to; particularly via walking, cycling and public transport. One indicator of the variability of travel patterns is the primary mode used to access work, compared across and within different cities. As illustrated in Figure 12 people living in the inner suburbs have a much lower dependence on motor vehicles (light passenger vehicles) with a greater proportion cycling, walking and using mass transit to work.



Source: BITRE 2013 derived from ABS 2011

Figure 12: Variability in the patterns of travel to work mode within and between Australian cities.

Distance to employment is a major factor influencing mode choice for daily commutes.[104] Increasing connections to work could be achieved in one of four ways:

1) Encouraging infill development in locations close to public transport and jobs;
2) Decentralisation of jobs to outer areas;
3) Changing worker behaviour and enabling people to work from home to reduce the reliance on daily commuting; and
4) Increasing opportunities for active transport modes in the suburbs.

The section that follows focuses on the last option.

6.2 Increasing opportunities for active transport modes in the suburbs

6.2.1 Increasing active travel accessibility to public transport

Integration of walking and cycling with public transport such as trains and buses is one means of increasing opportunities for active transport modes in the suburbs. In Australia's five major cities, trains provide a backbone for public transport systems. Figure 13 illustrates the mode of transport used in combination with trains for journey to work in five of Australia's major cities. As can be seen, walking is

the most the commonly used mode of transport in conjunction with train in journeys to work: nevertheless only a small proportion of people live within walking distance of a train.

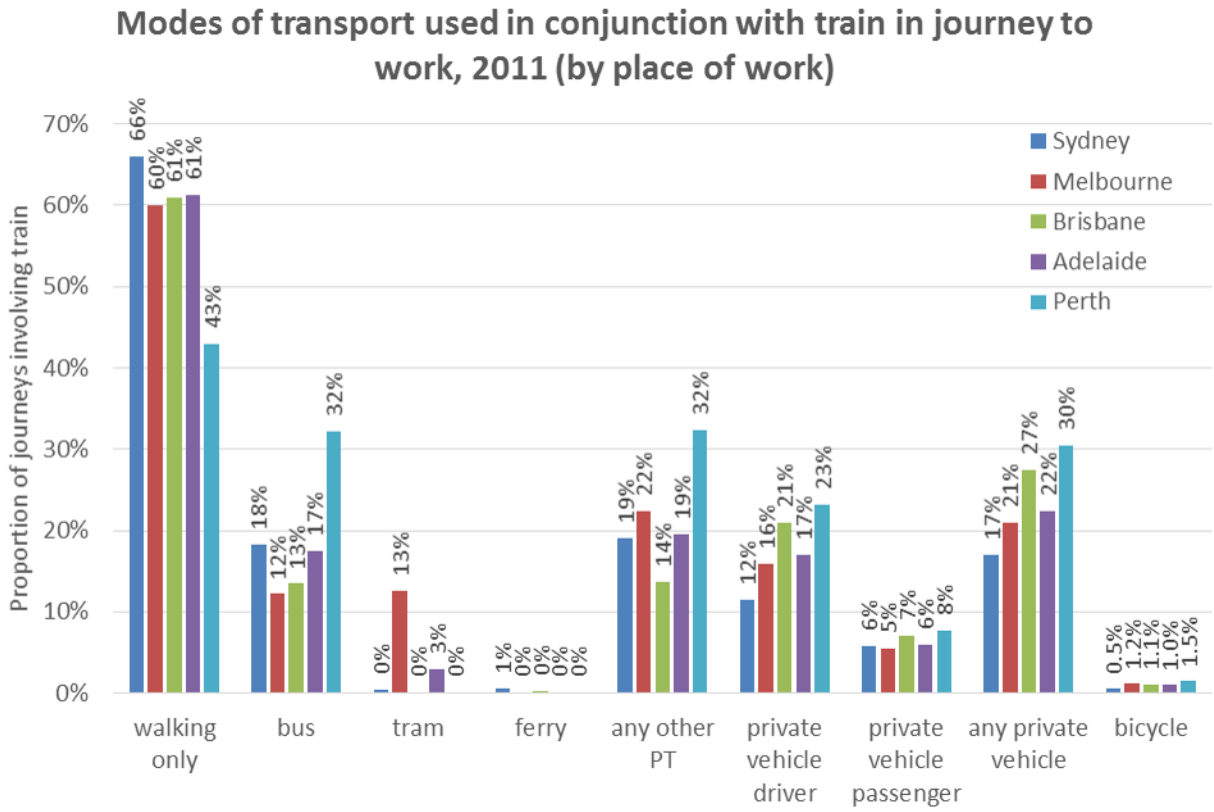


Figure 13: Models of transport used in conjunction with train in journey to work (2011), by city (Source: [128])

Increasing access public transport via walking and cycling offers promise for broadening the appeal and usage of mass transit in years to come, [129] while at the same time enhancing health and wellbeing by increasing physical activity. However, as highlighted by the Department of Infrastructure and Transport,[110] local street networks surrounding public transport services do not always support good walking or riding connections. For example, as Figure 14 shows, at Bull Creek station in Perth, Western Australia some houses are only 260 meters from the station in a direct line, but require a walk of up to 1,560 meters along the footpath or road network.

Figure 14: Image illustrating the direct (D) and actual (A) footpath distances required to reach the Bull Creek Station Source: adapted from [105], page 24**.**

Increasing the accessibility of train stations and activity centres in the suburbs via walking or cycling would increase the connections between transport modes while encouraging active transportation. This could be achieved in two complementary ways: increasing the accessibility of passenger trains using alternative modes or by increasing housing density and mixed use development around passenger train stations and activity centres.

What potential is there to increase cycling to public transport nodes? Figure 15 illustrates the number of people who used both bike and train for commuting in the 2006 and 2011 census. While numbers are modest, Melbourne and Perth saw the largest growth in numbers. Notably, both of these cities have invested in implementing bike parking systems at key stations [128].

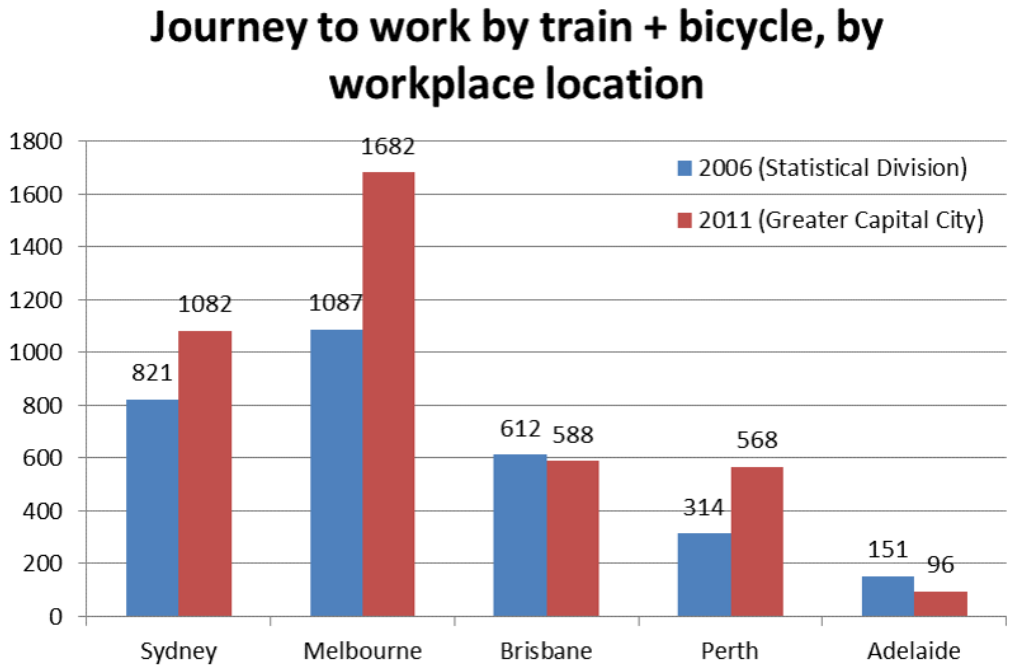


Figure 15: Journey to work by train and bicycle by Australian City[128]

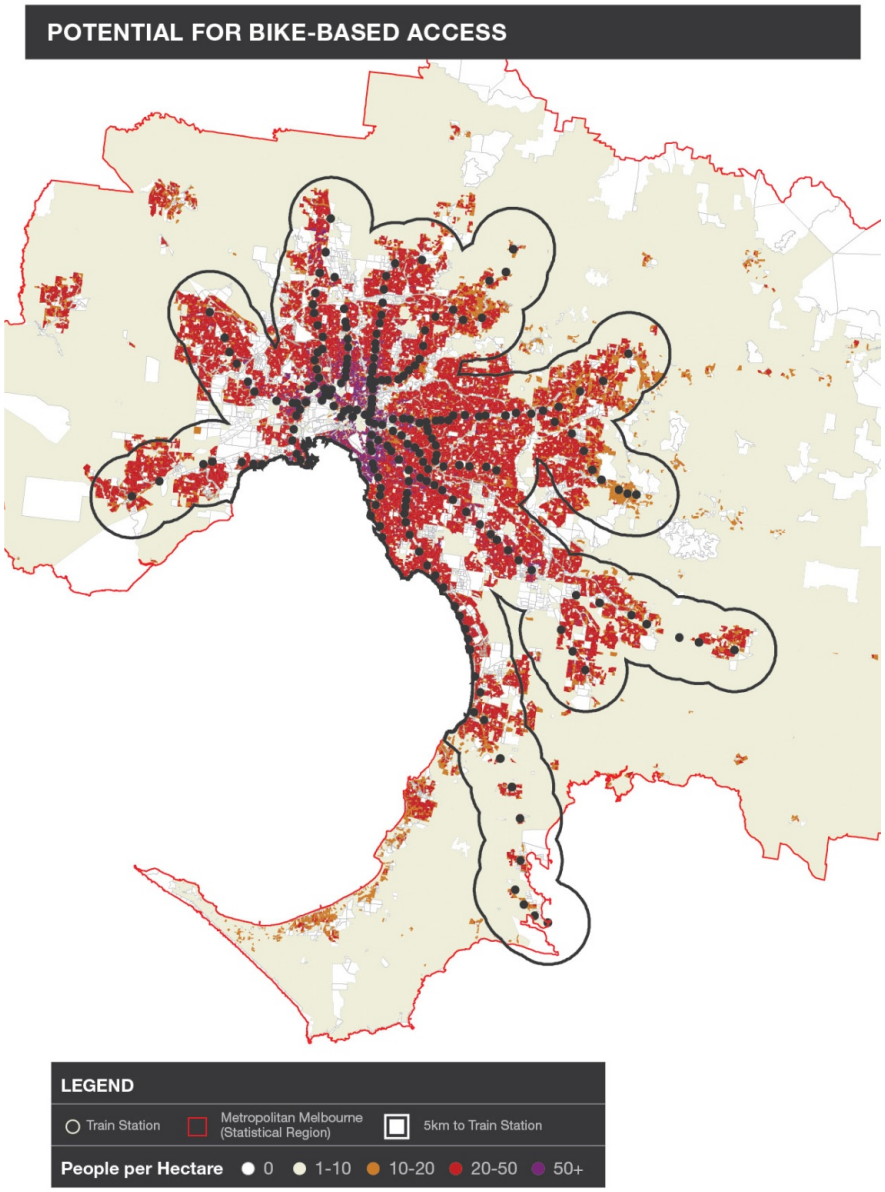
Table 5 shows the top nine bike access stations in Melbourne by mode share. At face value this is a disappointing list, in only offering 'higher' bike access mode shares of between 4% and 7.5% (Hale and Eagleson 2014). However, with the exception of Rushall, Anstey and Moreland, by international standards, the population densities around these train stations are extremely low offering only a limited opportunity for local residents to live within a walkable or easy cycling distance. On this basis, there appears to be a tremendous opportunity to increase the efficiency of land use around train stations.

Table 5: Bike Access to Train Stations in Melbourne.

Station	Bike access mode share %	Distance to CBD (Km)	Local Government	Population within 2km	Population within 5km	Density (2km) Persons/Ha	Density (5km) Persons/Ha
Beaconsfield	7.5	47	Cardinia	16,300	60,000	13	8
Upfield	5.2	19	Hume	13,100	104,000	10	13
Hampton	5.1	18	Bayside	23,700	115,000	19	14
Rushall	5	8	Yarra	50,100	281,000	40	35
Hurstbridge	4.8	38	Nillumbik	3,500	13,000	3	2
Anstey	4.2	8	Moreland	56,000	290,000	45	37
Seaholme	4.1	16	Hobsons Bay	7,000	48,000	6	6
Montmorency	4	47	Banyule	25,100	110,000	20	14
Moreland	4	44	Moreland	50,700	271,000	41	35

Source: Modified from[129]

Cycling studies have found that a cycling catchment is approximately nine times a walking catchment.[130] However, using a conservative cycling speed of 15 kph, this equates to a 20-minute ride within a 5 km catchment. Using this 5km benchmark there is great potential for Australian cities to improve the accessibility of train stations by enhancing cycling infrastructure in street networks surrounding train stations. Figure 16 and 17 use Melbourne and Sydney as case studies to show the potential for bike-based access to existing train stations.


POTENTIAL FOR BIKE-BASED ACCESS
LEGEND
Train Station
Metropolitan Melbourne (Statistical Region)
5km to Train Station
People per Hectare
0
1-10
10-20
20-50
50+

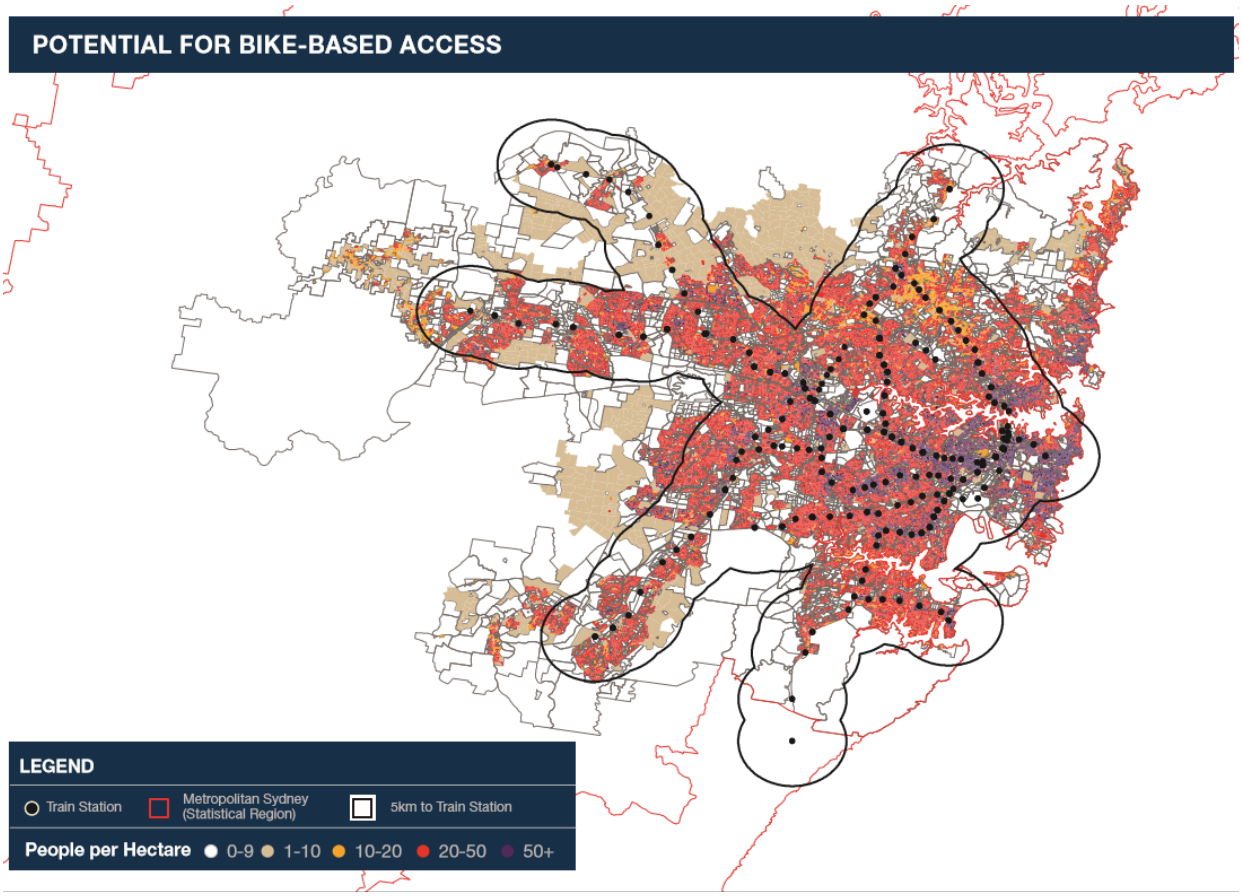


Figure 16 and 17: Potential for Bike based access to Train Stations in Melbourne and Sydney two of Australia's most populated cities. (Source based on [129])

6.2.2 Enhance land use and transport policy and implementation to support active transportation

The potential solutions discussed in this report require the involvement of a range of sectors to optimise land use and transportation planning, and to ensure that services and infrastructure are planned and located to facilitate active transportation. They also require the involvement of all levels of government in Australia, particularly state and local government. **Integrated planning is required across and between all levels of government to create coherent and consistent policies that support healthy and sustainable transportation**.

A growing number of planning policies and guidelines in Australia recognise the benefits of active transportation. This is particularly the case at the local government level, but also within state planning strategies such as Western Australia's sustainable cities initiative, *Liveable Neighbourhoods*,[131] state legislation such as Victoria's *Transport Integration Act 2010*, [132] and draft metropolitan planning strategies such as those for Melbourne[133] and Sydney. [134]

Despite progress, private motor vehicles continue to be prioritised over active transport in land use and transportation decisions, particularly by state and federal governments. For example, governments continue to spend over four times more on roads than rail.[135]

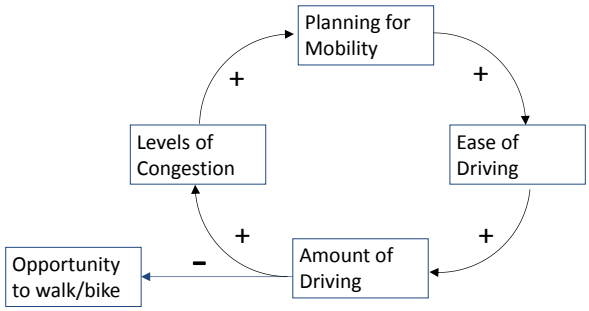
A sustainable transportation system that optimised health and wellbeing outcomes, would re-order policy and funding priorities in favour of transport modes that benefit health. **Following the example of cities like Vancouver, Canada, walking should be prioritised first, following by cycling, public transport, freight/shared vehicles and finally private motor vehicles.**[136] To this end, targets should be set for each major city in Australia, with the aim of increasing the mode share of active transport over time.

There is also a need to reconsider the economic basis for transportation decision-making, taking into account the many co-benefits of active transport. Current economic measures favour private motor vehicle use, without costing formulas fully accounting for health and environment externalities associated with private motor vehicle use – even if these are low emission vehicles. Moreover, the wider economic and social benefits of walking, cycling and public transport are often not accounted for.[36]

There is often a gap between policy and practice. Efforts to tighten the implementation of policies that support active transportation must therefore be strengthened. A Western Australian evaluation of the implementation of the state-government's Liveable Neighbourhood Guidelines, found that the policy was only 50% implemented, however for each 10% increment in implementation, the odds of people walking for transport increased by 50%.[137] This finding highlights the importance of closing the gap between policy and practice. This will require comprehensive implementation plans, with clear actions, targets, delegation of responsibility and review.[138, 139]

7.0 DRIVING FORCES FOR THE NEXT 25 YEARS

To secure Australia's future, consideration of sustainable transport mobility cannot be disentangled from sustainable land use. Handy argues for a shift away from traditional transportation planning with its focus on planning for mobility, to a focus on planning for accessibility (see Figures 18 and 19). A focus on accessibility will increase opportunities to walk and bike, and theoretically, reduce the need to drive.



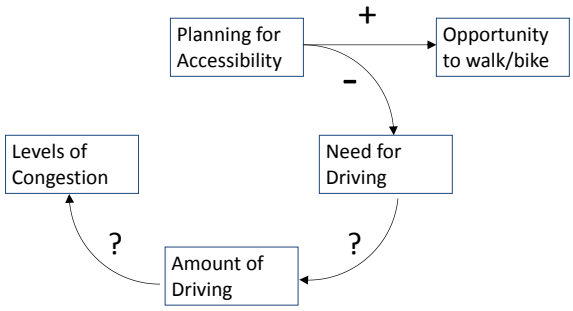


Figure 18: Traditional approach to transportation planning. **Figure 19:** Planning for accessibility rather than mobility

From a sustainable transportation perspective, the World Health Organisation [140] is now advocating that "Healthier lower-carbon transport strategies also are cost-efficient investments for individuals and societies". The costs associated with building networks to support walking and cycling, or siting schools in walkable neighbourhoods near residential areas, is a fraction of the cost of building roads and new vehicle technologies. In addition, from an equity perspective, the provision of effective public transport and connected and safe walking and cycling infrastructure, is more affordable than drive, while at the same time reducing inequalities in health, by promoting health-enhancing health behaviours and preventing disease.[141]

7.1 Consumer preferences

Australian Cities are already reporting a decline in the desire to drive. In Victoria, the percent of under 25 year olds with a driver's licence dropped from 77% in 2000-01 to 67% in 2011-12 [142]. In addition, there appears to be a change in consumer residential preferences. A US study [143] found that just 10% of respondents preferred a residential-only suburban neighborhood; and almost one half preferred to live in a walkable community with a mix of houses, shops, and businesses. Moreover, 60% reported they would

choose to live in a smaller house closer to their work to avoid lengthy commuting. Similar results have been found in New Zealand. Badland et al[144] found that most people preferred living in high-walkable areas (i.e., more convivial, smaller parcel blocks, higher mixed land use) rather than low-walkable suburban neighborhoods. This suggests a need to re-think the way we plan cities for this new paradigm of lower levels of driving and a growing preference for urban rather than suburban lifestyles.

7.2 Big Data

Big Data describes the exponential growth in the volume of structured and unstructured data that is currently being collected. Because Big Data takes time and money to load and analyse, new mechanisms for the collection and storage of this data are currently being developed. In the field of transport Big Data is obtained from many sources, including sensors, video, mobile devices, and social media. This data has the ability to assist researchers and planners to understand behaviour and apply immediate solutions to transport challenges. Over the next 25 years we expect that there will be rapid advances into the collection and analysis of Big Data related to people, transport and the interactions between them. However, there are current challenges in the fragmentation of data between the states and cities making it difficult to make comparisons and to conduct repeatable studies and analysis. Solving data quality and harmonisation issues will need to be a priority before the full potential of the use of Big Data can be fully realised.

8.0 SUMMARY OF FINDINGS

This report has examined how land use and transportation decisions impact on public health and considered potential solutions to transport-related health issues. A sustainable transport system that maximises health and wellbeing outcomes, will be one that prioritises the safety, accessibility and convenience of active transport over motorised transport. This could have significant direct health benefits through:

- Increased physical activity, including facilitating older adults to remain active as people age;
- Reduced respiratory illness from reduced transport-related air pollution;
- Reduced mental and physical health issues associated with transport noise;

Such an approach could also have indirect health benefits, such as:

- Reduced levels of obesity and chronic diseases associated with reducing physical inactivity, sedentary behavior;
- Contributing to mitigating the environmental and health impacts climate change.

However, as evidenced by this report, to encourage active modes of transport requires a re-think in the way we build cities and the way we prioritise transportation decisions in Australia. It will require prioritising walking, cycling, public transport and freight movements, over private motor vehicle use. It will also require integrated transportation and land use planning.

Transportation choices are shaped by, and have implications for, many policy sectors. This involves all levels of government in Australia, particularly state and local government. It is vital that sectors across and between levels of government work together in an integrated way to create urban environments that support healthy and sustainable transport. Public health can be protected and promoted through implementing land use and transportation policies that encourage:

- Infill development in locations close to public transport and jobs;
- Decentralisation of jobs to outer areas;
- Changing worker behaviour and enabling people to work from home to reduce the reliance on daily commuting; and
- Increasing opportunities for active transport modes in the suburbs by building walkable and cycle-friendly neighbourhoods; and increasing the accessibility of train stations and activity centres by

enhancing pedestrian and cycling infrastructure, and increasing the density of housing around public transport hubs.

Policymakers in Australia are increasingly recognising the many co-benefits of a multi-modal active transport system. However, to realise the health benefits discussed in this report, urban policies at all levels of government will need to prioritise, in order of importance, walking, cycling, public transport, freight and finally private motor vehicles. The implementation of policies that support active transportation must also be strengthened.

There are many future challenges for transportation in Australia, including changing transport preferences and meeting the needs of an ageing population. However, there are already signs of changing consumer preferences away from motor vehicles and towards urban rather than suburban development. The challenge of delivering a sustainable transportation system that optimises health and well-being will be best met by creating a comprehensive multi-modal transport system that incorporates active modes of transport (including public transportation) and low emission vehicles. However, as leading cities throughout the world are beginning to show, active modes (and freight) will need to be prioritised above private vehicles. To achieve this goal will require commitment to integrated transportation and land use planning and greater investment in public transport.

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