

Active transport: Adults

An overview of recent evidence

December 2009

Dr Jan Garrard

Active transport: adults

1 Physical activity and health

The health benefits of physical activity include increased life expectancy, physical fitness, energy, mental health, cognitive functioning, social connectedness, and independent living for older adults (Bauman 2004; Bull et al 2004). Physically active people are less likely to become overweight or obese, and to develop cardiovascular disease, type 2 diabetes, colon cancer, breast cancer, osteoporosis and depression (Bull et al 2004). Physically active adults in the workforce have lower rates of absenteeism and increased job satisfaction (Parks and Steelman 2008).

Despite these benefits, more than a third of Australian adults (34.6%) are classified as sedentary; that is, reporting no exercise (for fitness, recreation or sport) in the two weeks prior to interview (ABS 2009a). Physical inactivity is responsible for 6.6% of the total burden of disease and injury in Australia (Begg et al 2007), resulting in an estimated direct gross cost to the Australian health budget of \$1.49 billion per annum (Econtech 2007).

There is a marked social gradient for physical activity participation in Australia. People living in the most disadvantaged areas in Australia are nearly twice as likely to be sedentary (46.7%) as people living in the least disadvantaged areas (24.4%) (ABS 2009a). Several studies report either no comparable social gradient or the reverse relationship for active transport (Andersen et al 2000; Berrigan et al 2006; Agrawal and Schimek 2007; Barnett et al 2008). There is no consistent social gradient (based on education, occupation and income) for walking and cycling to work in Victoria (see Table 1).

Lack of time is consistently reported as a major constraint on participation in physical activity (Trost et al 2002). Building physical activity into the routines of daily life makes regular physical activity achievable for people who don't have the time, interest or money to participate in organised sports, exercise or fitness programs; or who don't see themselves as 'sporty types'. In the VicLANES study, up to one third of respondents cited 'not the sporty type' as a barrier to physical activity, second only to 'lack of time' for most gender/SES groups (Kavanagh et al 2007).

The promotion of 'lifestyle' physical activity such as walking and cycling is more cost-effective than structured exercise programs (Sevick et al 2000), and the regular short trips most people take to get around in their communities¹ are ideal for accumulating the recommended three 10-minute periods of moderate to vigorous physical activity on most days (Department of Health and Aged Care 1999). Frequent short trips can also contribute to low intensity physical activity and reduced periods of sedentary behaviour, both of which have recently been beneficially associated with metabolic risk variables such as adiposity, triglycerides, and 2-h plasma glucose (Healy et al 2008a; Healy et al 2008b).

Rates of active transport in Australia are low in comparison to many European and Asian countries, particularly for cycling (Figures 1-3). Numerous Local, Victorian and Federal Government policies across several sectors including health, transport, urban planning and the environment recommend a mode shift from car travel to active travel. Many Australians would like to increase their levels of walking and cycling, but are constrained by a number of barriers (Australian Associated Motor

¹ Residents in Melbourne and regional centres in Victoria average 3.3 trips per workday (Department of Transport 2009).

Insurers (AAMI) 2004; Garrard et al 2006; Daley et al 2007; Bauman et al 2008; Rissel et al in press, 2009).

Understanding the prevalence, trends and determinants of active travel, and the effectiveness of interventions aimed at increasing active travel, will assist in the processes of translating government policies and individual preferences into practice.

This report provides a summary of:

- The role of active transport in achieving recommended levels of physical activity
- Prevalence and trends in active travel in Australia
- Health and social benefits of active travel
- Characteristics and correlates of active travel
- Effectiveness of interventions aimed at increasing active travel
- Future directions for promoting active travel in Australia.

There are major opportunities for achieving large health gains for the... population by increasing levels of routine physical activity. Walking and cycling as means of daily transport can be a most effective strategy to achieve these gains. (World Health Organization 2002)

2 The role of active transport in achieving recommended levels of physical activity

The health benefits of walking and cycling for transport are well-established, and comparable to those traditionally associated with more structured sport and exercise programs. A recent meta-analysis of eight studies of the relationship between active commuting and cardiovascular risk reported an 11% overall reduction in cardiovascular risk (based on end-points including mortality, incident coronary heart disease, stroke, hypertension and diabetes) (Hamer and Chida 2008a). A meta-analysis of 18 studies on walking reported risk reductions of 31% for cardiovascular disease, and 32% for all-cause mortality (Hamer and Chida 2008b). The greater risk reductions for walking than 'active commuting' may be due to the low levels of active commuting observed in most of the studies, which were largely conducted in countries with relatively low levels of active travel. If the range of activity levels in the sample is low (ie little difference between people with 'high' and 'low' levels of active commuting), relative risk reductions are correspondingly low.

Few studies have focused on commuter walking, but commuter cycling has been shown to:

- reduce all-cause mortality (Andersen et al 2000)
- improve physical performance (VO₂max), particularly for those with a low initial fitness level for whom a single trip distance of 3 km per day on at least 4 days per week was sufficient to improve physical performance (Hendriksen 1996; Hendriksen et al 2000)
- have a favourable effect on body fat markers and body mass gain (Wagner et al 2001)
- reduce the risk of colon cancer, and breast cancer in women, and improve cancer survival (Matthews et al 2007; Orsini et al 2008)
- be associated with reduced overweight/obesity (Bassett Jr et al 2008; Wen and Rissel 2008).

Physical activity through active travel is more equitably distributed than leisure-time physical activity. While socio-economically advantaged population groups are about twice as likely as disadvantaged groups to participate in leisure-time physical activity or sports, the reverse relationship is often observed for active transport. Higher levels of participation in active travel for socially disadvantaged population groups or areas have been reported in Denmark (Andersen et al

2000), Canada (Barnett et al 2008), the Netherlands (vanLenthe et al 2005) and the US (Agrawal and Schimek 2007; Berrigan et al 2006). The distribution of income groups for pedestrians and cyclists on the journey to work in Victoria broadly follows that of the total journey to work population (Bartley Consulting Pty Ltd 2008), indicating absence of the social gradient found for leisure-time physical activity and sports in Australia (Australian Bureau of Statistics 2009a).

In addition to socio-economically disadvantaged population groups, other priority groups for the promotion of physical activity in Australia include women, adolescent girls and older adults. In countries with high rates of active travel, these population groups achieve high levels of physical activity through active transport as a 'habitual' part of daily life (Garrard 2008 Appendix B; Shephard 2008). The socially inclusive, population-wide participation associated with active travel may help to explain the inverse relationship between active travel rates and obesity levels internationally (Bassett et al 2008).

In an assessment of the contribution of active commuting to population health, Shephard (2008) concludes that:

A gross weekly energy expenditure of at least 4 MJ is recommended to reduce all-cause and cardiovascular mortality. This can be achieved by walking 1.9km in 22 minutes twice per day, 5 days per week, or by cycling at 16 km/h for 11 minutes twice per day, 5 days per week.

These trips can be walking or cycling only, or undertaken in association with public transport use. Data on the time spent walking or cycling to public transport are not available in Australia, but in the US, Besser and Dannenberg (2005) reported that "Americans who use transit spend a median of 19 minutes daily walking to and from transit."

Householders in metropolitan Melbourne averaged 3.2 trips per weekday (3.5 in regional Victoria) in 2007/8. In Melbourne 50% of all weekday trips were less than 4.7 km long and 41% were car trips (Department of Transport 2009). These distances can be covered in up to 20 minutes by bicycle or up to 50 minutes by brisk walking; providing, or substantially contributing to the recommended amount of daily physical activity.

As with most forms of physical activity, there are injury risks as well as health benefits associated with walking and cycling for transport. In transport terms, walking and cycling generally carry a 5-10 times higher risk of injury per kilometre travelled than driving a car (World Health Organization 2004; Elvik 2009). However, when viewed from the perspective of physical activity and health, the benefits in terms of life expectancy have been estimated to be 20 times the injury risks (for cycling) (British Medical Association 1992). An Australian study also concluded that, even under current road and traffic conditions in Australia, the health benefits of cycling outweigh the health costs (Roberts et al 1996).

There is considerable room for further improvements in these benefit/risk ratios, because modal shifts from car use to active travel are associated with lower injury rates for pedestrians and cyclists (Jacobsen 2003). A recent modelling of the 'safety in numbers' effect for pedestrians and cyclists found that if a substantial share of trips by motorised transport is transferred to walking or cycling, the total *number* of road traffic crashes (including multi-vehicle and single-vehicle car crashes, as well as pedestrian-car and cyclist-car crashes) is reduced (Elvik 2009). More commonly, *rates* of pedestrian, cyclist and overall road traffic injuries are observed to decline as active travel mode share increases (Pucher and Buehler 2008; Litman and Doherty 2009).

The overall evidence indicates that participation in levels of active transport observed in several developed European and Asian countries is sufficient to produce significant, multiple, and equitably distributed health outcomes.

3 Active transport in Australia and internationally

Eighty per cent of employed people in Victoria aged 15 years and over on census day in 2006 (Tuesday 8th August) travelled to work by car, with relatively few people walking (4%) or cycling (1%) (Figure 1). Data for the Melbourne metropolitan area and for Australia as a whole are very similar.

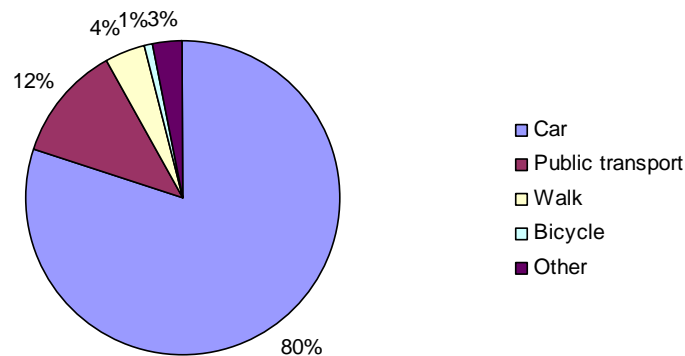


Figure 1: Method of travel to work, all employed persons aged 15 years and over
(Source: ABS 2006 Census online)

Australia has no national data on all trips (ie including non-work trips and all people). However, the *Victorian Integrated Survey of Travel and Activity 2007 (VISTA 2007)*, conducted in the Melbourne metropolitan area and Victorian regional centres, provides data on all trips for all household members at all times of the year. These data show that, while car travel is the dominant mode of travel (78% of all trips), householders are more likely to walk for non-work trips than for journey to work trips (Figure 2).

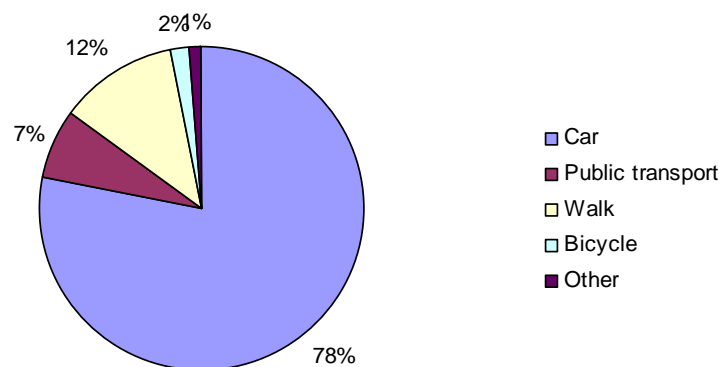


Figure 2: Weekday travel trips by mode, all householders, VISTA 2007
(Source: Department of Transport 2009)

The large difference in percentage of walking trips between journey to work in the 2006 Census (4%) and VISTA (12%) is likely to be due to:

- More walking trips for purposes other than travelling to work (eg shopping, socialising, access to services, recreation). In VISTA, work-related trips comprised only about 20% of all trips by adults. In sprawling cities like Melbourne, trips to work are longer than many other trips, and trip distance is a major determinant of walking for transport (see Section 5).
- The census data are for employed persons aged 15 years and older, while VISTA includes all adults regardless of employment status. Some people not in the paid workforce may be less likely to own a car and therefore more likely to walk for short trips (eg people on low income, students, older adults).

International comparative data indicate relatively low rates of active transport in Australia, particularly for cycling (Figure 3).

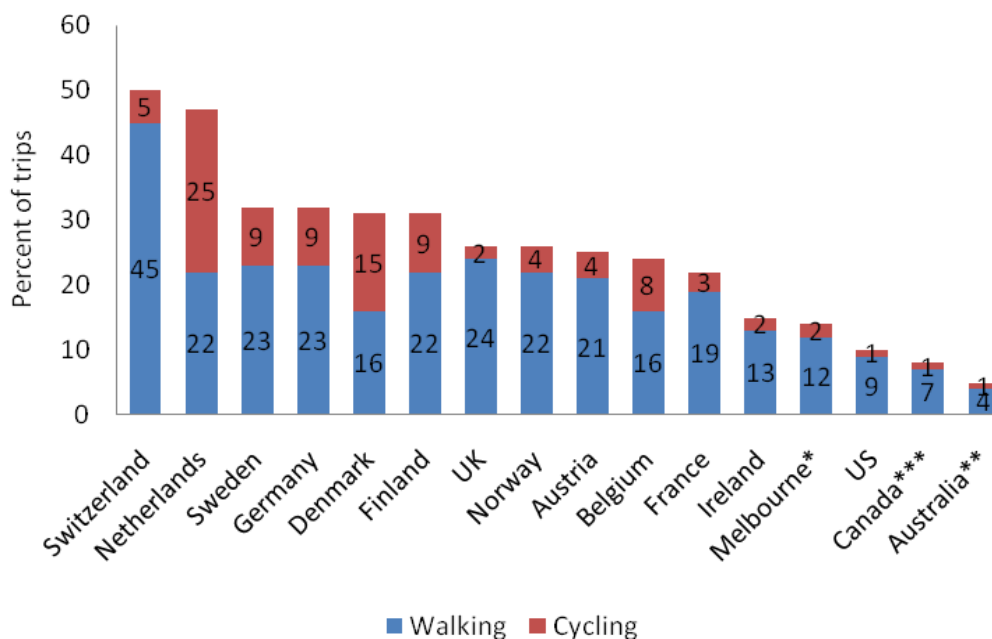


Figure 3: Cycling and walking shares of urban trips in Europe, Canada, USA, Melbourne and Australia

(Sources: adapted from Bassett et al 2008; Ironmonger 2008; Bartley Consulting Pty Ltd 2008)
 *All trips (VISTA 2007), **Journey to work (2006 Census), ***Work trips only

Trend data for Australian adults' modes of transportation are available from the population census (journey to work, 1976 to 2006) and ABS household surveys of transportation modes (principally journey to work or study, 1996-2006). These data show a consistent pattern of a steady increase in car use and decline in active travel (walking, cycling and public transport) from 1976 to 1996, followed by modest increases in travel mode shares for walking, cycling and public transport in most Australian capital cities between 1996 and 2006 (Australian Bureau of Statistics 2007; Mees et al 2008).

In Victoria, nearly all of the growth in walking and cycling to work between 1996 and 2006 has been in the greater Melbourne metropolitan area, with regional Victoria showing small declines between 1996 to 2001, and small increases between 2001 and 2006 (Bartley Consulting Pty Ltd 2008).

Some of the characteristics of walking and cycling for transport in Victoria (ABS journey to work data) and Melbourne (VATS/VISTA data) are summarised in Table 1.

Table 1: Demographic characteristics of walking and cycling for transport

Demographic characteristics	Walking for transport*	Cycling for transport*
Gender	Slightly more females than males (rate ratio of 1.2 to 1). (ABS)	More males than females (rate ratio of 2.9 to 1). (ABS)
Age	Walking to work peaks in the 15-24 years age range. Relative to working population age distribution, walking to work declines most markedly in 35-54 age range. (ABS)	Cycling to work peaks in the 25-34 years age range. Older adults less likely to cycle to work. (ABS)
Education	Similar levels of post-school level qualifications relative to Victorian working population. (ABS)	Higher levels of post-school qualifications relative to Victorian working population. (ABS)
Occupation	White collar workers over-represented in population of pedestrians in Victoria. Consistent pattern for Melbourne and Regional Victoria. (ABS)	White collar workers slightly under-represented in population of cyclists in Victoria. Regional variations: white collar workers over-represented in Melbourne and under-represented in regional Victoria. (ABS)
Income	Lower income groups over-represented in population of pedestrians relative to working population in Victoria. (ABS)	Higher income groups over-represented in population of cyclists relative to working population in Victoria. (ABS)
Number of trips per week	Women: 7.6 Men: 6.6 Children: 5.0 (VATS)	Women: 0.7 Men: 0.6 Children: 0.2 (VATS)
Total distance per week (estimated)	Women: 5.0 km/week Men: 4.7 km/week Children: 3.5 km/week (VATS)	Women: 2.2 km/week Men: 1.8 km/week Children: 0.5 km/week (VATS)
Trip distance	Precise distance of walking trips to work not available, but 94.5% of walking trips to work or study in Australia are less than 5 km. (ABS 2007)	Journey to work to Melbourne LGA place of work, men: 8.2 km; women: 6.1 km (ABS)

Time	Women: 69 minutes/week Men: 60 minutes/week Children: 46 minutes/week (VATS)	Women: 11 minutes/week Men: 10 minutes/week Children: 2 minutes/week (VATS)
Geographic location	Regional Victoria: 5% mode share** Melbourne: 3% mode share** (ABS)	Regional Victoria: 1.1% mode share Melbourne: 1.2% overall mode share. Mode shares as high as 5-8% in some inner urban LGAs (ABS)

*Characteristics may be different for recreational walking and cycling.

**walked only

Note: ABS data are for journey to work (Victoria and Melbourne); VATS data are for all trips in the Melbourne Statistical Division

(Sources: Ironmonger and Norman 2007; Bartley Consulting Pty Ltd 2008; ABS 2007; ABS 2006 Census online)

4 Health and social benefits of active travel

Walking and cycling are healthy modes of travel that can also contribute to environmental sustainability, social cohesion, reduced traffic congestion, lower road transportation costs, and improved community liveability (Forsyth et al 2009; Litman and Doherty 2009).

On the Australian population census day (Tuesday 8th August 2006), out of 1,875,838 employed people aged 15 years or older in Victoria who travelled to work:

- 1,501,953 travelled to work by car (80%)
- 81,239 people walked to work (4%)
- 25,121 people cycled to work (1%)

The 106,360 people in Victoria (69,803 in Melbourne) who walked or cycled to work on census day in 2006:

- Cycled an average of 6.1 km (women) and 8.2 km (men)² (State of Victoria 2009), or walked about 2 km³ per trip.
- Cycled a total of 387,944 km and walked a total of 308,708 km (696,652 km total)⁴.
- On average, achieved the recommended daily level of moderate to vigorous physical activity⁵.
- Saved about \$63 million annually in health care costs, based on \$0.376 per km (Bauman et al 2008).
- Contributed to improved air quality in Melbourne, saving \$1.2 million to \$5.9 million annually in motor vehicle air pollution costs (Litman 2006). Up to 80% of air pollution in Melbourne is due to motor vehicle emissions (Environment Protection Authority Victoria 2009b). Each year in Australia air pollution from cars causes between 900 and 2,000 early deaths and between

² Based on trip length into the Melbourne local government area (data for Victoria as a whole unavailable).

³ Average trip length for the journey to work in Australia is unknown, but in the US it is 1.9km (Krizek et al 2009).

⁴ Assuming the return trip from work to home was also by foot or bicycle.

⁵ Based on an average cycling speed of 15-20 km/h; walking speed of 4-5 km/h; and a similar return trip from work to home (Bauman 2004).

900 and 4,500 cases of bronchitis, cardiovascular and respiratory disease, costing between \$1.5 and \$3.8 billion (Bureau of Transport and Regional Economics 2005).

- Contributed to a quieter environment. Motor vehicle noise is the main, loudest and most disturbing source of noise pollution in Melbourne (Environmental Protection Authority 2007).
- Reduced greenhouse gas emissions by 254 tonnes on the day of travel⁶ (Environment Protection Authority Victoria 2009a). Transport is responsible for the highest proportion of household greenhouse gas emissions (34%), compared with home heating and cooling (11%) and lighting (5%) (Department of the Environment Water Heritage and the Arts 2008).
- Freed up more than 479km of (single-lane) road space - the approximate length of 106,360 cars; OR
- Replaced 500 tram services or 122 train services (VicRoads 2009a).
- Took up a small fraction of the space requirements of a car. Pedestrian, cyclist, train passenger and single-occupant vehicle space requirements have been estimated at 0.8, 3, 1.5-4.6 and 60 m² per person respectively (Whitelegg 1993). Based on these estimates, a single-occupant car requires 75 times more space than a pedestrian, and 20 times more space than a cyclist.
- Saved about \$19 million in traffic congestion costs in Melbourne (per annum). The current economic costs of congestion in Melbourne are estimated to be \$3 billion per year (Bureau of Transport and Regional Economics 2007).
- Used transport infrastructure (eg off-road shared pedestrian/bicycle path) which is between one-hundredth and one-thousandth of the cost of a freeway (per km) (Bicycle Victoria 2009).
- Completed the average cycling trip to work (7.7km) in a time similar to that required to travel the same distance by car in Melbourne. In the morning peak (7.30 to 9.00 am) in Melbourne, average car travel speeds in 2006/07 were 23km/h on undivided arterial roads and 20.4km/h on arterial roads with trams. At an average cycling speed of 20km/h, a 7.7 km trip to work takes an estimated 3 minutes longer (on undivided arterial roads) to 30 seconds longer (arterial roads with trams) by bicycle than by car (VicRoads 2009b).
- Personally saved between \$16 and \$43 on the daily cost of driving a car (RACV 2009).
- Improved Australia's economic competitiveness. In cities that are heavily car dependent, transport costs take up a substantially higher proportion of the city's wealth (Newman nd).
- Contributed to the \$16 billion annual subsidy enjoyed by car drivers in Australia – the difference between the annual costs of car use in Australia (\$47 billion) and the annual revenue collected from Australian motorists (\$31 billion) (Public Transport Users Association 2007).

The benefits outlined above are for the journey to work which represents only 22% of vehicle-kilometres travelled in Australia. The remaining 78% of travel, which is predominantly by motor vehicle, has the potential to provide additional benefits (Austroads 2005).

The benefits of active transport outlined above are those that are able to be quantified. Additional benefits that are difficult to quantify include improved community liveability and social inclusion associated with more equitable access to personal mobility for all ages, genders and incomes (see Section 2). Transport costs (principally motor vehicle related) account for a high proportion of household expenditure on goods and services in Australia (16%) – second only to expenditure on food and non-alcoholic beverages, and similar to housing costs (16%) (Australian Bureau of Statistics (ABS) 2006). One in 10 households in the Melbourne metropolitan area does not have a motor vehicle, rising up to 30% in some disadvantaged areas of Melbourne (Department of Sustainability and Environment nd). Lower income households also experience greater harms associated with car use due to poor air quality, vehicle noise and road transport injuries (Evans and Kantrowitz 2002).

⁶ Based on the greenhouse gas emissions (CO₂ equivalents) of an 'average' single-occupant motor vehicle.

Car reliance and associated excessive motor vehicle traffic also contribute to urban sprawl, and restrict children’s independent mobility and opportunities for outdoor play and social interactions (Frumkin et al 2004; Litman 2004; Carver et al 2008; Handy et al 2008).

5 Characteristics and correlates of active travel

Understanding the determinants of active travel behaviour is important for developing interventions aimed at increasing active travel. A number of characteristics of walking and cycling for transport are well-understood, but consistent evidence for a wide range of proposed correlates of active travel is surprisingly sparse. In their recent review of evidence related to the promotion of walking and cycling for transport, Krizek et al (2009) commented that:

Fully understanding NMT [non-motorised travel] is an extremely complex endeavour that requires the analyst to wade through muddied waters and to consider multiple reasons for use and multiple outcome measures.

And:

In most studies aiming to predict various dimensions of travel behaviour, more than 70 percent of the variation in the data goes unexplained. (Krizek et al 2009 p.10).

Current research evidence on the characteristics and correlates of walking and cycling for transport is summarised in Table 2.

Table 2: Characteristics and correlates of walking and cycling for transport

Characteristics and correlates	Walking	Cycling
Accessibility	Accessible to most people	Requires equipment and higher order road skills than walking
Distance	Not suitable for longer trip distances	Suitable for a wide range of trip distances
Speed	3-6 kph	15-30 kph
Health benefit	Present for commuter walking, increases with time and intensity	Generally greater than for walking due to greater intensity of effort (WHO 2002)
Interface with public transport	Convenient; but limited catchment area (walking distance to train, bus and tram stops)	Requires bicycle parking or carrying facilities; but increases the catchment area for public transport use
End of trip facilities	Minimal requirements	Secure bicycle parking, and change facilities for longer and/or faster cycling trips
Infrastructure	Footpaths and road crossings	Bicycle paths, lanes and intersection treatments
Planning responsibility	Land use planning, local government responsibility (principally)	Transport planning, state (principally) and local government
Safety	Requires safety from crime and traffic	Principally requires safety from traffic

Traffic calming	Likely positive impact both directly and indirectly via perceptions of improved safety	More effective if system-wide (eg reduced speed limits) rather than small area treatments.
Culture, custom and habit	Under-researched for walking, but may be important.	Key influence on transportation cycling.
Built environment	Population density, street connectivity and mixed land use generate short, walkable trips.	Urban form less important than system-wide pro-cycling transportation provision.
Natural environment	Terrain: inconsistent evidence Weather: inconsistent evidence	Flat terrain. Weather not as important as often indicated in self-report surveys. In contrast to recreational cycling, commuter cycling in Melbourne declines by only a small amount in winter (VicRoads 2009c).

(Sources: Forsyth et al 2009; Krizek et al 2009; Pucher et al 2010 in press)

Much of the public health research literature on factors associated with active travel focuses on the perceived benefits and barriers of active travel, and largely ignores the fact that travel mode choices involve weighing up the perceived benefits and barriers of alternative travel modes. In this sense, 'barriers' to active travel include the convenience, comfort, and perceived speed and low cost of car travel. Some of the apparent benefits of car use are perceptual, socially constructed, or the result of transport market distortions (Public Transport Users Association 2007; Litman 2009).

Australians underestimate the cost of car travel by about half and overestimate travel speed (Tranter 2004). Subsidized car travel also distorts travel choices (Public Transport Users Association 2007; Litman 2009), with many of the costs of driving apparently free to the car driver. Parking provision is a key determinant of car use in urban areas (Newman and Kenworthy 1999). Notwithstanding the high costs of parking *provision*, it has been estimated that in the US "99 percent of all car trips begin and end at a parking space that is free to the driver" (Shoup 2005, cited in Krizek et al 2009).

Removing these market distortions changes travel behaviour. A US study found that the perception of parking difficulty was the strongest association with weekly travel walking and total walking (Rodriguez et al 2008). In the 2005 Household Travel Survey conducted in the Sydney Greater Metropolitan Area, the most frequently cited reason for using public transport to travel to work was "avoiding parking problems and/or costs" (48% of respondents) (Ministry of Transport 2007). When residents are required to pay the true cost of car parking, many choose not to own a car (Rosenthal 2009), and "when the marginal cost of parking is internalized to the users, people are less likely to take car trips" (Shoup 2005, cited in Krizek et al 2009). The current price of a car parking bay in the Melbourne CBD is between \$34,000 and \$75,000 per bay, depending on location within the CBD (Craig and Greenblat 2009). Some or all of this cost is frequently borne by businesses and/or government (ie consumers and taxpayers) rather than the individual parking the car.

Interventions based only on the determinants of active travel are less likely to be effective than those that also consider the determinants of the alternative behaviour (car driving). The community-based social marketing model developed by McKenzie-Mohr and Smith (1999) provides a framework for considering the perceived benefits and barriers for both active travel (as the target behaviour)

and car travel (as the competing behaviour). Examples of possible perceived benefits and barriers to both active and inactive travel are outlined in Table 3.

Table 3: Perceived benefits and barriers of active and inactive modes of travel

	Target behaviour (active travel)	Competing behaviour (car travel)
Perceived benefits	Improves health	Saves time
Perceived barriers	No safe route	Difficult and/or costly to park car

In summary, the complex pattern of correlates of active travel (the “muddied waters” referred to by Krizek et al [2009]) is likely due to:

- Multiple travel (and physical activity) choices, with associated benefits and barriers
- Multiple travel purposes
- Complex interactions between perceptions and actual conditions
- Unrecognised influences on travel behaviours (eg ‘habit’, internalised social norms).

Understanding the complex factors and interactions that influence travel mode choices is important for planning interventions. The following ‘case study’ illustrates the value of critically examining apparently straightforward correlates of active travel.

Complex influences on active travel: a case study of travel distance

Travel distance is one of the most well-established and apparently straightforward correlates of active travel (Forsyth et al 2009), but the relationship is in fact a complex one. Travel distance depends on trip purpose. Walking and cycling trips undertaken for fitness and exercise (sometimes incorporating transport) are generally longer than transport trips to work, which in turn are longer than local trips to shops, services and facilities (Krizek et al 2009). A Victorian study of the interface between recreational and transport cycling found that for some fitness/recreational cyclists the trip to work is too *short* to cycle (ie insufficient length to meet their fitness training needs) (Berends 2006).

Perceptions of a walkable or bikeable distance are also important. In the 2006 ABS household survey of transport use, distance was the only significant reason why people did not usually walk or cycle to their place of work or study (70% of respondents) (ABS 2007). However, there is evidence of important perceptual, cultural or experiential components of the concept of “too far to walk or cycle”. Figures 4 and 5 show substantially higher rates of walking and cycling for comparable (relatively short) distances in the Netherlands compared with Australia. In Australia, 70% of short trips to work or study (less than 5 km) are by car, while in the Netherlands, only 35% of short trips (up to 7.5 km) are by car, and the majority of trips up to 7.5 km are active trips (cycling and walking) (Ministry of Transport Public Works and Water Management 2007). While these data are not directly comparable because the Netherlands data are for all trips while Australian data are for trips to work or study, they are indicative of substantial differences in perceptions of feasible walking and cycling trip distances.

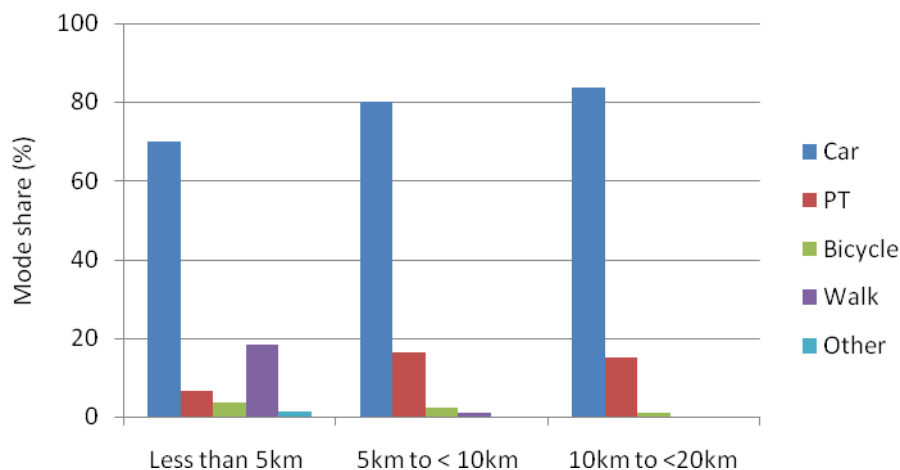


Figure 4: Distance by travel mode, Australia (ABS 2007)

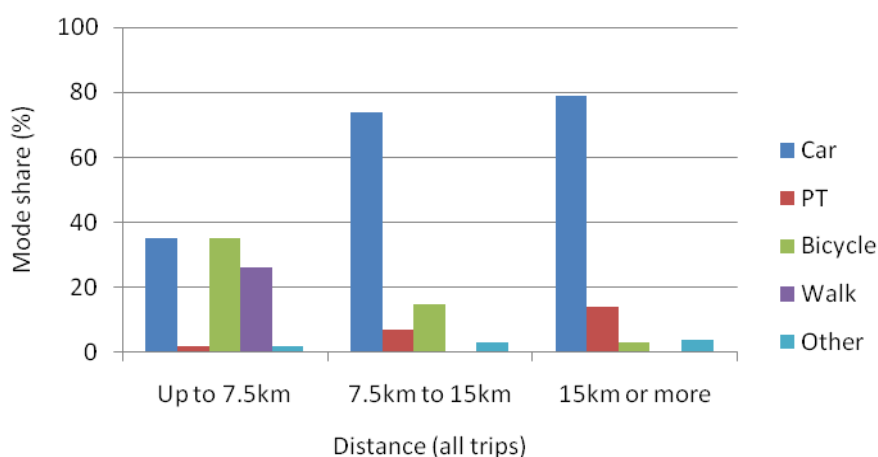


Figure 5: Distance by travel mode, the Netherlands

(Source: [Dutch] Ministry of Transport Public Works and Water Management 2007)

The complex relationship between trip distance and active travel has also been critically examined in reviews of evidence in the planning and transportation fields (Forsyth et al 2009).

Given the inherent complexities in understanding travel mode choices, and the limitations of cross-sectional studies for providing consistent evidence of key correlates of active travel, it is important to understand ‘what works?’ in addition to ‘why is it so?’ The following section provides a summary of evidence for the effectiveness of interventions aimed at increasing active travel.

6 Effectiveness of interventions aimed at increasing active travel

The evidence base for effective interventions aimed at increasing active transportation and decreasing private motor vehicle use is diverse - spanning urban planning, transport, environmental sustainability, and, most recently, public health (Forsyth et al 2009). While the health sector focuses on rigorous evaluation of controlled interventions, the urban planning and transportation sectors also draw on more macro-level policy evaluation. This research summary includes evidence from the evaluation of discrete programs as well as macro-level policies.

Table 4 provides a summary of the impacts of active transport interventions based on several reviews and multiple forms of evidence.

Table 4: Impact of interventions aimed at increasing walking and cycling for transport

	Walking for transport	Cycling for transport
Urban planning policies	Community design features such as density and street pattern, or linkages to public transport, may have more effect on travel walking than pedestrian infrastructure, amenities, and general aesthetics. Findings about footpaths are mixed.	Pro-cycling transportation provision has a greater impact on cycling than urban density, street patterns and mixed land use per se. (see 14 case studies in Pucher et al 2010 in press).
Policies that restrict car use⁷	Increased walking	Increased cycling
Traffic calming	Increased walking	Increased cycling
Traffic safety policies that emphasise driver responsibility for avoiding crashes with pedestrians and cyclists	May be effective as part of a package of pro-pedestrian policies.	May be effective as part of a package of pro-cycling policies.
Public transport provision	Increased walking	Under-researched, but likely to have a smaller impact on cycling than walking.
Active transport infrastructure in general	Increased walking	Increased cycling
Separated facilities such as off-road paths	Little evidence due to lack of research. Many walking studies do not distinguish between recreational and transport walking.	Some evidence of increased cycling, provided facilities enable relatively direct access to trip destinations.
On-street bicycle lanes, wide curb lanes, and other non-intersection specific treatments	Not applicable	Inconsistent evidence. <i>Perceptions</i> of increased safety may be an important factor.
Bicycle loan programs	Not applicable	Some evidence of increased cycling.
Improving access and safe bicycle parking at train stations.	Not applicable	Some evidence of increased cycling.
Behaviour change programs, including 'one-off' ride or walk to work days	<ul style="list-style-type: none"> ■ Some, but not all, effective in short-term. ■ 'One-off' events effective on the specified day(s). ■ Some evidence of sustained changes. 	<ul style="list-style-type: none"> ■ Some, but not all, effective in short-term. ■ 'One-off' events effective on the specified day(s). ■ Some evidence of sustained changes. ■ For programs directed at reduced car use (eg TravelSmart), increases in public transport use and walking exceed increases in cycling.

⁷ Restrictions on car use include congestion charging, limited car parking, car-free zones, comprehensive traffic calming and lower overall speed limits, all of which reduce the overall convenience and attractiveness of car use (Pucher et al 2010 in press).

Skills training	Not applicable	Some evidence of increased cycling.
Integrated, multi-component strategy ⁸	Increased walking at population level.	Increased cycling at population level.

(Sources: WHO 2002; Pucher et al 2010 in press; Pucher and Buehler 2008; Forsyth et al 2009; Krizek et al 2009; Litman 2009)

In their recent review of the effectiveness of infrastructure, policies and program measures aimed at increasing cycling, Pucher et al (2010 in press) report that some individual interventions can increase cycling to varying degrees, but the increases are not usually large. In contrast to the small and variable impacts reported for individual interventions, substantial population-level changes have been observed following the implementation of integrated packages of interventions. The authors therefore included fourteen case studies of cities that have adopted comprehensive packages of interventions. Almost all of the case study cities, which included cities of varying sizes from several countries (eg London, Bogota, Berlin, Paris, Barcelona, Copenhagen, Amsterdam, and Portland, Boulder and Davis in the USA), experienced large increases in levels of cycling and cycling mode share of trips (Pucher et al 2010 in press). The authors conclude that:

Substantial increases in bicycling require an integrated package of many complementary interventions, including infrastructure provision, and pro-bicycle programs, as well as supportive land use planning and restrictions on car use.

Similar ‘integrated packages’ are required to increase population-wide levels of walking for transport.

In their review of the potential for increasing active transport, Forsyth et al (2009) recommended that research, policy and practice should focus on:

- Incorporating active transport into transportation models and regional funding processes.
- More carefully crafting policy messages to a practice audience—evidence for whom?
- Demonstrating a wider range of benefits and outcomes, including economic ones.

The authors also identified four key motivations for active transport: (1) congestion relief, (2) environmental conservation, (3) liveability, and (4) health; and argued that of the four motivations, liveability, while difficult to define, is the most compelling justification for creating a mode shift from motorised to non-motorised travel (Forsyth et al 2009).

Creating a level playing field for travel choices

The decision to walk, cycle or drive involves weighing up (often implicitly) the perceived benefits and barriers of these alternate travel modes. In Australia, active travel choices are more difficult choices because, for several decades, transportation policies have favoured car use and created barriers to active transport (Mees et al 2008; Public Transport Users Association 2009).

In developed countries such as Australia it is well documented that car users, on average, pay less for mobility privileges than other modes of transport (Krizek et al 2009). Transportation market distortions include “various types of underpricing of motorized travel, planning practices that favour

⁸Integrated range of environmental features (including infrastructure and facility improvements), pricing policies, and education programs (Pucher et al 2010 in press).

automobile travel over other modes, and land use development practices that create automobile-dependent communities” (Litman 2006, p. 19). Transportation policy reforms can assist in establishing a more level playing field where car users assume a larger share of the costs for the externalities (eg pollutants) they generate (Krizek et al 2009). Policies aimed at improving transport equity include those summarised in Table 5.

Table 5: Policies for reducing car use subsidisation and their impact on car travel

Reform	Typical Fee	Travel Impacts
Convert currently fixed insurance and registration fees into distance-based fees	3-6 cents per vehicle-km	10% mileage reduction per affected vehicle
Charge motorists directly for using parking facilities	\$1-5 per trip, or 6-12 cents per vehicle-km	10-20% mileage reduction
Charge motorists directly for all roadway costs	3-6 cents per vehicle-km	10% mileage reduction
Environmental fees (additional fees for air, noise and water pollution)	1-3 cents per vehicle-km	2-5% mileage reduction

(Source: adapted from Litman 2006, p.29)

7 Future directions for promoting active travel in Australia

Achieving a better balance between active and inactive forms of personal travel is both desirable and possible. Definitive, rigorous evidence of the effectiveness of specific interventions is not available and, due to the complexities involved, probably never will be. It is therefore important to use the best available evidence as a basis for planning, implementing and evaluating policies and programs as part of an ongoing process of ‘learning by doing’.

Several countries, regions, cities and localities have adopted transport and planning policies that achieve a more sustainable balance of motorised and non-motorised travel. This can also be achieved in Australia. A number of recent reviews recommend that sustained, population-wide mode shifts from inactive to active travel require:

- Integrated, multi-faceted strategies incorporating urban planning and transportation infrastructure measures; policies that treat walking and cycling as legitimate, desirable and cost-effective forms of transport; and education, skills training and promotional programs.
- Networks of safe walking and cycling infrastructure and facilities rather than spot treatments and designated routes.
- Educational and promotional programs that address real and *perceived* barriers and supports (eg walkable distances, relative travel times and costs, personal and traffic safety).
- Interventions targeting the multiple settings of daily life – schools, workplaces, shopping centres, services and communities.
- A combination of population-wide and targeted interventions (eg women, adolescents, older adults).
- Interventions aimed at changing current social norms of travel behaviour in Australia (eg car use as the ‘default setting’ even for short trips).
- Targeting periods of transition (eg commencing school, university/TAFE, or work; changing place of residence; delaying car purchase among young people).
- ‘Market segmentation’ in terms of walking/cycling, work/non-work trips, stand-alone/chained trips (eg linked to public transport).
- Reductions in current subsidies and incentives for car use.

- Advocacy for public, political and media support for policy change (eg reduced urban speed limits, reversing subsidized car use, restrictions on car use including parking provision).
- Match policy arguments for active transport to potentially differing and locally identified needs (eg congestion reduction and community liveability may be stronger arguments for active travel than health or environmental concerns [Rose 1999; Forsyth et al 2009]).

(Sources: Pucher and Buehler 2008; Krizek et al 2009; Forsyth et al 2009; Department of Transport 2009 - Victorian Cycling Strategy; Pucher et al 2010 in press)

Consistent with many of these recommendations for increasing active transport, the Victorian Cycling Strategy identifies five strategic directions for supporting cycling:

- Build networks to connect communities
- Promote and encourage a culture of cycling
- Reduce conflicts and risks for cyclists
- Better integrate cycling with public transport
- Integrate cycling into land use planning.

(State of Victoria 2009)

A Victorian Walking Strategy is currently being developed, but the *Victorian Transport Plan* and *Keeping Melbourne Moving* describe the following priority actions for pedestrians:

- Introduce more appropriate speed limits in shopping strips.
- Encourage through-traffic to avoid shopping strips and to use alternative routes where feasible.
- Improve the amenity of areas of intense pedestrian activity alongside arterial roads.
- Improve pedestrian safety near schools located on arterial roads through a State-wide program of school speed limits.
- Improve safety and provide more equitable access for pedestrians in high-use areas such as Transit Cities and multi-modal facilities via the Walk Safe Program and other innovative and cost-effective measures.
- Establish a program to provide greater priority for pedestrian access across busy arterial roads that sever community activities.

8 Conclusion

The overall evidence indicates that participation in levels of active transport observed in several developed European and Asian countries is sufficient to produce significant, multiple, and equitably distributed health outcomes.

Many Australians enjoy walking and cycling, but are constrained by social, policy and environmental factors that make active travel choices difficult choices (Australian Bureau of Statistics 2009b).

The experience of several affluent European and Asian countries demonstrates that active travel choices can be easy choices, including within urban environments similar to the low population density suburbs surrounding Australian cities (Mees 2009). With the right conditions, policies, education and encouragement, more Australians would undoubtedly walk (up to about 2km) or cycle (up to about 10km) to work, study and other destinations.

References

- Agrawal, A, Schimek, P (2007). Extent and correlates of walking in the USA. *Transportation Research Part D* 12(8): 548-563.
- Andersen, LB, Schnohr, P, Schroll, M, Hein, HO (2000). All-cause mortality associated with physical activity during leisure time, work, sports, and cycling to work. *Arch Intern Med* 160(11): 1621-1628.
- Australian Associated Motor Insurers (AAMI) (2004). Personal communication.
- Australian Bureau of Statistics (ABS) (2009a). *National Health Survey 2007-08: summary of results. Cat. No. 4364.0*. Canberra, ABS.
- Australian Bureau of Statistics (2009b). *Environmental issues: waste management and transport use, Cat. No. 4602.0.55.002*. Canberra, ABS.
- Australian Bureau of Statistics (2007). *Environmental issues: people's views and practices, Cat. No. 4602.0*. Canberra, ABS.
- Australian Bureau of Statistics (ABS) (2006). *Household Expenditure Survey, Australia: Summary of Results, 2003-04, No. 6530.0*. Canberra, Commonwealth of Australia.
- Austroroads (2005). *RoadFacts 2005*. Canberra, Austroroads.
- Barnett, TA, Gauvin, L, Craig, CL, Katzmarzyk, PT (2008). Distinct trajectories of leisure time physical activity and predictors of trajectory class membership: a 22 year cohort study. *International Journal of Behavioral Nutrition and Physical Activity* 5: 57 doi:10.1186/1479-5868-5-57.
- Bartley Consulting Pty Ltd (2008). *Walking and cycling: census analysis*. Melbourne, Bartley Consulting Pty Ltd.
- Bassett Jr, DR, Pucher, J, Buehler, R, Thompson, DL, Crouter, SE (2008). Walking, cycling, and obesity rates in Europe, North America, and Australia. *Journal of Physical Activity and Health* 5(6).
- Bauman, A (2004). Health benefits of physical activity for older adults: epidemiological approaches to the evidence. *Optimizing exercise and physical activity in older people*. M. Morris and A. Schoo. Sydney, Butterworth-Heinemann: 1-25.
- Bauman, A, Rissel, C, Garrard, J, Ker, I, Speidel, R, Fishman, E (2008). *Cycling: Getting Australia Moving: Barriers, facilitators and interventions to get more Australians physically active through cycling*. Melbourne, Cycling Promotion Fund.
- Begg, S, Vos, T, Barker, B, Stevenson, C, Stanley, L, Lopez, AD (2007). *The burden of disease and injury in Australia 2003*. Canberra, Australian Institute of Health and Welfare.
- Berends, J (2006). *Exploring the interactions between recreational and utilitarian cycling. Unpublished Honours Thesis*. Melbourne, Deakin University.
- Berrigan, D, Troiano, RP, McNeel, T, DiSogra, C, Ballard-Barbash, R (2006). Active Transportation Increases Adherence to Activity Recommendations. *American Journal of Preventive Medicine* 31(3): 210-216.
- Besser, L, Dannenberg, A (2005). Walking to public transit: steps to help meet physical activity recommendations. *American Journal of Preventive Medicine* 29(4): 273-280.
- Bicycle Victoria (2009). *Transport statistics*. Retrieved 26 August 2009, from <http://www.bv.com.au/change-the-world/10549/>.
- British Medical Association (1992). *Cycling towards health and safety*. London, Blackwell BMJ Books.
- Bull, F, Bauman, A, Brown, W, Bellew, B (2004). *Getting Australia Active II: An update of evidence on physical activity for health*. Melbourne, National Public Health Partnership (NPHP)
- Bureau of Transport and Regional Economics (2007). *Estimating urban traffic and congestion cost trends for Australian cities, Working Paper 71*. Canberra, Department of Transport and Regional Services.
- Bureau of Transport and Regional Economics (2005). *Health impacts of transport emissions in Australia: economic costs*. Canberra, Department of Transport and Regional Services.
- Carver, A, Timperio, A, Crawford, D (2008). Playing it safe: The influence of neighbourhood safety on children's physical activity--A review. *Health & Place* 14(2): 217-227.

- Craig, N, Greenblat, E (2009). *Car park values remain strong*. Melbourne, *The Age*, 27 May 2009.
- Daley, M, Rissel, C, Lloyd, B (2007). All Dressed Up and Nowhere to Go?: A Qualitative Research Study of the Barriers and Enablers to Cycling in Inner Sydney *Road & Transport Research* 16(4).
- Department of the Environment Water Heritage and the Arts (2008). *Households and climate change*. Retrieved 29 January, 2009, from <http://www.environment.gov.au/settlements/gwci/households.html>.
- Department of Health and Aged Care (1999). *National physical activity guidelines for Australians*. Canberra, Department of Health and Aged Care.
- Department of Sustainability and Environment (nd). *Know your area*. Retrieved 1 November, 2008, from <http://www.doi.vic.gov.au/doi/knowyour.nsf>.
- Department of Transport (2009). *Victorian integrated survey of travel and activity 2007 (VISTA 2007)*. Melbourne, Department of Transport.
- Econtech (2007). *Economic modelling of the net costs associated with non-participation in sport and physical activity*. Canberra, Econtech.
- Elvik, R (2009). The non-linearity of risk and the promotion of environmentally sustainable transport. *Accident Analysis and Prevention* 41(4): 849-55.
- Environment Protection Authority Victoria (2009a). *Motor vehicle emissions and air quality*. Melbourne, EPA.
- Environment Protection Authority Victoria (2009b). *Car EcoMeter*. Retrieved 27 August 2009, from <http://www.epa.vic.gov.au/air/carecometer/default.asp>.
- Environmental Protection Authority (2007). *Noise surveys 2007*. Melbourne, EPA.
- Evans, G, Kantrowitz, E (2002). Socioeconomic status and health: the potential role of environmental risk exposure. *Annual Review of Public Health* 23: 303-331.
- Forsyth, A, Krizek, KJ, Rodríguez, DA (2009). Chapter 3. Non-motorised travel research and contemporary planning initiatives. *Progress in Planning* 71(4): 170-183.
- Frumkin, H, Frank, L, Jackson, R (2004). *Urban sprawl and public health. Designing, planning and building for healthy communities*. Washington, Island Press.
- Garrard, J (2008). *Taking action on obesogenic environments: building a culture of active, connected communities. An options paper prepared for the National Preventative Health Taskforce*. Melbourne.
- Garrard, J, Crawford, S, Hakman, N (2006). *Revolutions for women: increasing women's participation in cycling for recreation and transport*. Melbourne, Deakin University.
- Hamer, M, Chida, Y (2008a). Active commuting and cardiovascular risk: a meta-analytic review *Preventive Medicine* 46(1): 9-13.
- Hamer, M, Chida, Y (2008b). Walking and primary prevention: a meta-analysis of prospective cohort studies. *British Journal of Sports Medicine* 42(4): 238-43.
- Handy, S, Cao, X, Mokhtarian, P (2008). Neighborhood Design and Children's Outdoor Play: Evidence from Northern California. *Children, Youth and Environments* 18(2): 160-179.
- Healy, GN, Wijndaele, K, Dunstan, DW, Shaw, JE, Salmon, J, Zimmet, PZ, Owen, N (2008a). Objectively measured sedentary time, physical activity, and metabolic risk: the Australian Diabetes, Obesity and Lifestyle Study (AusDiab). *Diabetes Care* 31(2): 369-371.
- Healy, GN, Dunstan, DW, Salmon, J, Cerin, E, Shaw, JE, Zimmet, PZ, Owen, N (2008b). Breaks in sedentary time: beneficial associations with metabolic risk. *Diabetes Care* 31(4): 661-666.
- Hendriksen, I (1996). *The effect of commuter cycling on physical performance and on coronary heart disease risk factors*. Amsterdam, Free University.
- Hendriksen, IJM, Zuiderveld, B, Kemper, HCG, Bezemer, PD (2000). Effect of commuter cycling on physical performance of male and female employees. *Medicine and Science in Sports and Exercise* 32(2): 504-510.
- Ironmonger, D, Norman, P (2007). *Travel behaviour of women, men and children: what changes and what stays the same?* 29th Annual Conference on Time Use Research, Washington, DC.

- Jacobsen, PL (2003). Safety in numbers: more walkers and bicyclists, safer walking and bicycling. *Injury Prevention* 9: 205-209.
- Kavanagh, A, Thornton, L, Tattam, A, Thomas, L, Jolley, D, Turrell, G (2007). *Place does matter for your health*. Melbourne, Key Centre for Women's Health in Society, The University of Melbourne.
- Krizek, K, Forsyth, A, Baum, L (2009). *Walking and cycling international literature review*. Melbourne, Victorian Department of Transport.
- Litman, T (2006). Transportation market distortions. *Berkeley Planning Journal* 19: 19-36.
- Litman, T (2004). *Quantifying the benefits of nonmotorized transportation for achieving mobility management objectives*. Victoria, British Columbia, Canada, Victoria Transport Policy Institute.
- Litman, TA, Doherty, E (2009). *Transportation cost and benefit analysis: techniques, estimates and implications*. Canada, Victorian Transport Policy Institute.
- McKenzie-Mohr, D, Smith, W (1999). *Fostering Sustainable Behavior: An Introduction to Community-Based Social Marketing*. Canada, New Society Publishers.
- Matthews, C, Jurj, A, Shu, X, Li, H, Yang, G, Li, Q, Gao, Y, Zheng, W (2007). Influence of exercise, walking, cycling, and overall nonexercise physical activity on mortality in Chinese women. *American Journal of Epidemiology* 165(12): 1343-1350.
- Mees, P (2009). *We can keep our leafy suburbs and still save the planet*. Melbourne, *The Age*, 23 November.
- Mees, P, O'Connell, G, Stone, J (2008). Travel to Work in Australian Capital Cities, 1976-2006. *Urban Policy and Research* 26(3): 363-378.
- Ministry of Transport (2007). *2005 Household Travel Survey Summary Report*. Sydney, Transport Data Centre.
- Ministry of Transport Public Works and Water Management (2007). *Cycling in the Netherlands*. The Hague.
- Newman, P (nd). *A sustainable cities framework for community housing*. Retrieved 26 August, 2009, from <http://www.communityhousing.com.au/resources/Newman%20-%20Keynote.doc>
- Newman, P, Kenworthy, J (1999). *Sustainability and cities: overcoming automobile dependence*. Washington D. C., Island Press.
- Orsini, N, Mantzoros, C, Wolk, A (2008). Association of physical activity with cancer incidence, mortality, and survival: a population-based study of men. *British Journal of Cancer* 98: 1864-1869.
- Parks, KM, Steelman, LA (2008). Organizational wellness programs: A meta-analysis. *Journal of Occupational Health Psychology* 13(1): 58-68.
- Public Transport Users Association (2007). *Common urban myths about transport: Motorists pay more in taxes and fees than is spent on roads*. Retrieved 17 January, 2009, from <http://www.ptua.org.au/myths/petroltax.shtml>.
- Pucher, J, Dill, J, Handy, S (2010 in press). Infrastructure, programs and policies to increase bicycling: an international review. *Preventive Medicine* 48(2).
- Pucher, J, Buehler, R (2008). Making Cycling Irresistible: Lessons from The Netherlands, Denmark and Germany. *Transport Reviews* 28(4): 495-528.
- RACV (2009). *Vehicle operating costs*. Retrieved 27 August 2009, from <http://www.racv.com.au/wps/wcm/connect/racv/Internet/Primary/my+car/advice+ +information/vehicle+operating+costs/>.
- Rissel, C, Merom, D, Bauman, A, Garrard, J, Wen, L, New, C (in press, 2009). *Current cycling, bicycle path use and willingness to cycle more - findings from a community survey of cycling in south-west Sydney*. Australia.
- Roberts, I, Owen, H, Lumb, P, MacDougall, C (1996). *Peddalling health: health benefits of a modal transport shift*. Adelaide, University of Adelaide.
- Rodríguez, D, Aytur, S, Forsyth, A, Oakes, J, Clifton, K (2008). Relation of modifiable neighborhood attributes to walking. *Preventive Medicine* 47(3): 260-4.
- Rose, G (1999). *A comprehensive evaluation of 'Safe Routes to School' implementation*. Melbourne, Institute of Transport Studies, Monash University

- Rosenthal, E (2009). *Beyond the torque: Germany leads the way in creating auto-ban suburbs*. Melbourne, *The Age*, 16 May 2009.
- Sevick, MA, Dunn, AL, Morrow, MS, Marcus, BH, Chen, GJ, Blair, SN (2000). Cost-effectiveness of lifestyle and structured exercise interventions in sedentary adults: Results of project ACTIVE. *American Journal of Preventive Medicine* 19(1): 1-8.
- Shephard, R (2008). Is active commuting the answer to population health? *Sports Medicine* 38(9): 751-758.
- State of Victoria (2009). *Victorian Cycling Strategy*. Melbourne, State of Victoria.
- Tranter, P (2004). *Effective speeds: car costs are slowing us down*. Canberra, Australian Greenhouse Office, Department of the Environment and Heritage. .
- Trost, S, Owen, N, Bauman, A, Sallis, J, Brown, W (2002). Correlates of adults' participation in physical activity: review and update. *Medicine and Science in Sports and Exercise* 34(12): 1996-2001.
- vanLenthe, F, Brug, J, Mackenbach, J (2005). Neighbourhood inequalities in physical inactivity: the role of neighbourhood attractiveness, proximity to local facilities and safety in the Netherlands. *Social Science and Medicine* 60(4): 763-775.
- VicRoads (2009a). *Keeping Melbourne moving: walking and cycling*. Retrieved 26 August, 2009, from <http://www.vicroads.vic.gov.au/Home/RoadsAndProjects/Keeping+Melbourne+Moving/Keeping+Melbourne+Moving+-+Walking+and+Cycling.htm>
- VicRoads (2009b). *Traffic system performance monitoring 2006/07*. Melbourne, VicRoads.
- VicRoads (2009c). *Cycling data and statistics*. Retrieved 26 August 2009, from <http://www.vicroads.vic.gov.au/Home/BicyclesPedestrians/DevelopingBicycleNetworks/CyclingDataAndStatistics.htm>.
- Wagner, A, Simon, C, Ducimetiere, P, Montaye, M, Bongard, V, Yarnell, J, Bingham, A, Hedelin, G, Amouyel, P, Evans, A, Arveiler, D (2001). Leisure-time physical activity and regular walking or cycling to work are associated with adiposity and 5 y weight gain in middle-aged men: the PRIME Study. *International Journal Of Obesity And Related Metabolic Disorders: Journal Of The International Association For The Study Of Obesity* 25(7): 940-948.
- Wen, LM, Rissel, C (2008). Inverse associations between cycling to work, public transport, and overweight and obesity: Findings from a population based study in Australia. *Preventive Medicine* 46(1): 29-32.
- Whitelegg, J (1993). Time pollution. *The Ecologist* 23(4): 131-134.
- World Health Organization (2004). *World report on road traffic injury prevention*. Geneva, WHO.
- World Health Organization (2002). *Physical activity through transport as part of daily activities*. Copenhagen, WHO Regional Office for Europe.