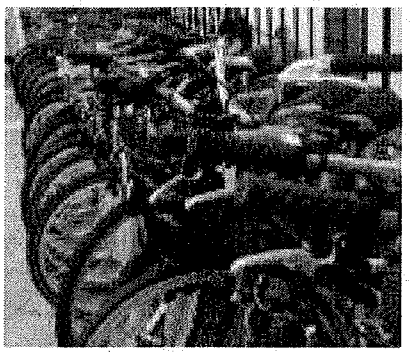

Cycling for active transport and recreation in Australia: Status review and future directions

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Introduction

An important priority for health promotion in the 21st century is increasing the levels of physical activity for whole populations. Physical inactivity is the second (after tobacco smoking) most important behavioural cause of ill-health in society (AIHW, 1999). The majority of adult Australians are not physically active at the level recommended to achieve health benefits (AIHW, 2004). Physical inactivity is a major modifiable risk factor for cardiovascular disease (CVD) and independently affects other CVD risk factors such as type II diabetes, total blood-cholesterol level, obesity and hypertension (USDHH, 1999; Bauman and Owen 1998).

The energy expenditure to achieve population level increases in physical activity levels is most likely to be sustained if incorporated into daily routines. Therefore, the concept of 'active transport' is an important one. The term 'active transport' relates to physical activity undertaken as a means of transport (Davis, 1999). This includes travel by foot, bicycle and other non-motorised vehicles (Mason, 2000). Among the three major active transport modes (ie public transport, walking and cycling), cycling is currently the least used in Australia, although all three have the potential for substantial increases (Austroads, 2005).

In Australian state capitals, the proportion of trips taken by bicycle ranges from one to five per cent, while the proportion of Australians owning bicycles ranges from 30-65 per cent (Australian Bicycle Council, 2004). In many European cities the proportion of trips taken by bicycle is over 25 per cent of all trips (ADONIS, 1998). Over half (55%) of car trips in Sydney and other capitals are less than five kilometres and 33 per cent are less than three kilometres (NSW Department of Transport, 1995), distances considered easily amenable to cycling.

While there are many European examples of policy and practice that have contributed to increases in levels of cycling (Pucher and Dijkstra, 2003), there is very little Australian research to provide evidence to policy makers on effective interventions to promote cycling. The purpose of this paper is to review all the published and as much of the unpublished 'grey' Australian literature that could be found that addresses the promotion of cycling, and that has an evaluation component that allows the identification of effective interventions or factors that influence population levels of cycling.

Method

The electronic data-bases MEDLINE, PUBMED, and APAIS were searched for the years 1995-2005 using the terms "cycling", "cyclist", "cycl*" and "bicycles". The Google internet search engine was

used to help locate possible reports or papers that described the evaluation of interventions to promote cycling. Further, the authors contacted all major Australian cycling organisations or persons active in the promotion of cycling in Australia to identify unpublished evaluation reports of cycling promotion programs.

Papers or reports that focused on the health benefits of cycling were excluded, as this has been internationally well researched with unequivocal results of the positive health benefits (see for example papers or articles by Paffenberger et al (1986), Roberts et al (1996), Anderson et al (2000), Hu et al (2003), and Steindorf et al 2003)). Papers dealing with the use of bicycle helmets and injury issues were also excluded, even though the mandatory wearing of helmets in Australia may adversely influence population frequency of cycling (Jacobsen, 2003; Robinson, 2005) by acting as a general, albeit small deterrent to everyday or casual cycling. While safety concerns directly impact on population levels of cycling, the injury prevention literature is distinct from that of cycling promotion, and is not included in this review.

Physiological focused papers on athletic performance represented more than half of the articles retrieved from the literature search. However, articles dealing with competitive sport and elite cycling were also excluded, as this area of cycling is quite specialised and restricted to a relatively small proportion of the population. There is much greater potential for population-wide participation in cycling and physical activity through a focus on cycling for transport and recreation.

Cycling prevalence in Australia

Limited data on cycling prevalence in Australia are available from the national census (every five years), transport surveys, and special purpose studies. Data have been collected in the transport, health, sport, recreation and tourism sectors, often using inconsistent measures. This review focuses on data related to cycling for transport and recreation. These are described separately, though in some studies no distinction is made between these two forms of cycling.

Cycling as a means of transport

Unlike other modes of transport, data on cycling as a means of transport is poor. National population census data are available for journey to work only, which represents travel on only one day in the middle of the Australian winter. Travel surveys that include all forms of cycling for transport have been conducted in a limited number of Australian states, cities or regions. No consistent national data are available.

In the 2001 Australian Census of Population and Housing, 0.94% of employed persons aged 15 years and over travelled to work by bicycle (Bell, Garrard and Swinbourne, in press). There was a marked gender difference, with 0.40% of women cycling to work, compared with 1.39% of men (Bell, Garrard and Swinbourne, in press). Cycling prevalence was highest in the Northern Territory for men (4.19%) and women (2.37%), followed by the Australian Capital Territory (2.70% and 0.96% respectively). Cycling prevalence was highest in the youngest age groups (15-24 years and 25-34 years) and declined thereafter with age, except for a small increase in the 75 and older age group). Cycling prevalence declined for

men (from 1.45% to 1.39%) from 1996 to 2001 and increased marginally for women (0.37% to 0.40%).

The 1996 and 2001 censuses were collected on a single day in August (the middle of the Australian winter). Wet weather and limited daylight hours can adversely influence a person's decision to cycle to work. The Victorian Activity and Travel Survey for the period 1997 to 1999 indicated up to 30% more cycling trips undertaken in autumn than in winter (VicRoads, 2004). Therefore, the above cycling prevalence data underestimates the yearly prevalence of cycling to work in Australia.

The Victorian Activity and Travel Survey (VATS) is an example of a survey that measures all travel by all modes by all people in the surveyed households (McGinley, 2003). While it records all bicycle trips (and not just journey to work), the sample of 14,874 households with 30,464 household occupants (comprising 770 individuals, 2.52%, who reported using a bicycle on their allocated travel day) is drawn only from metropolitan Melbourne. This does suggest that the prevalence of cycling is higher in urban areas compared with rural areas.

For the data collection period 1997 to 1999 in the VATS, approximately 75% of cyclists are male, and 49% are less than 20 years old (mainly in the 10-20 years age group). On average, 1.2% of all trips in Melbourne are by bicycle, more than by bus (1%) or tram (1%). The average number of bicycle trips is 0.07 trips per person per day, although this varies by locality, with cycling for transport decreasing from 3.7% of trips in central Melbourne to 1.3% in the inner suburbs to 1.0% in the outer suburbs to 0.9% in outer metropolitan regions of Melbourne. A higher percentage of bicycle trips are made on weekends than on weekdays. The majority of bicycle trips are up to 1 km in length (36%) and nearly 90% of bicycle trips are 5 km or less. Cycling to work accounts for the highest proportion of all bicycle trips (14%). It should be noted that the VATS survey data include bicycle trips undertaken for recreational purposes.

In a survey of physical activity levels of South Australian adults conducted in 2004 by the South Australian Department of Health, 8.5% of respondents reported cycling at least once a week (Gill and Taylor, 2005). Almost five per cent (4.8%) of respondents had cycled for at least 10 minutes for recreation only in the past week, 1.6% had cycled for transport only, and 1.4% for both recreation and transport.

In metropolitan Sydney in 1998, one percent of the population cycles everyday, which represents 91,000 bicycle trips each week day (Transport Data Centre, 2003). However, there are marked regional differences, with some inner Sydney areas seeing 2-3% of journeys to work, and outer suburbs seeing less that 1% (Telfer and Rissel, 2003). There has been a 64% increase in cycling to work in the inner Sydney areas between the 1996 and 2001 censuses (Telfer, 2003). In 1998, the majority of Sydney riders (58%) were male (Transport Data Centre, 2003).

Cycling for recreation

Annual surveys of participation of Australians aged 15 years and over in exercise, recreation and sport have been conducted by the Australian Sports Commission from 2001 to 2004 (Australian Sports Commission 2005). Cycling, with a participation rate of 10.5% in 2004, is the fourth most

popular activity after walking (39%), aerobics/fitness (17.1%) and swimming (16.5%). Participation in cycling increased by 15.3% from 2001 to 2004 (Australian Sports Commission 2005).

Participation in recreational cycling events

State-based bicycle advocacy organisations conduct a range of single-day rides and multi-day bicycle tours. Analysis of the ride participant database of the largest and most active of these organisations, Bicycle Victoria (BV), reveals that there were 208,244 participants in eight BV-organised rides and tours from 1994 to 2004 (Garrard and Crawford, 2005).[26] Overall, participation in BV rides increased by an average of 10.8% per annum from 1994 to 2004, with much of this increase occurring between 2001 and 2004.

Gender differences in the shorter distance recreational cycling events are generally not as great as for cycling for transport, averaging about 30% across all rides. The longer recreational cycling events attract relatively fewer female participants, with the 210 km Victorian 'Around the Bay in a Day' ride comprising 12% females (Garrard and Crawford, 2005).

Influences on cycling

Demographic influences on cycling in Australia include age, gender, socio-economic status and location. The highest level of recreational cycling (at least once in the past year) occurs in those aged 25-34 years, and declines steadily with older age (Australian Bicycle Council, 2004). The age distribution of participants in cycling events organised by Bicycle Victoria shows a slightly older age distribution though comparisons are made more difficult due to the use of different age ranges (Garrard and Crawford, 2005). This could reflect age differences in frequency of cycling (most event participants train in preparation for rides and are therefore likely to cycle more than once a year); real age differences in participation in organised events compared with recreational cycling, or the possibility of differences between Victoria and the rest of Australia. The Australian Bureau of Statistics journey to work data indicates that cycling for transport (national census data) has high levels of participation among people aged 15-24 years that is similar to that of people aged 25-34 years, and shows a similar decline with age as for recreational cycling (Bell, Garrard and Swinbourne, in press).

There are substantial gender differences in cycling in Australia. The female rate of Australian commuter cycling is less than one third that of the male rate, and similar gender differences occur for recreational cycling (Garrard, 2003). In contrast, in several western European countries commuting cycling rates are high, and women cycle more frequently than men (Garrard, 2003). In Australia, women cycle shorter distances than men and have a stronger preference for cycling on bicycle paths, which provide separation from motor vehicles (Garrard et al, personal communication). Female cyclists' income distribution is similar to the general Victorian population, but male cyclists are more likely to be in lower and higher income groups (Garrard et al, personal communication).

Barriers to cycling

Of the approximately 40-50 per cent of the Australian population that have access to a bicycle and are healthy enough to ride one, and looking at those

trips where using a bicycle is feasible, there are different influences on cycling dependent on individual current cycling behaviour. For example, for persons not currently riding a bike, or not having done so for several years, then the barriers and motivations to cycle are different compared with someone who is a current recreational rider, or a regular cycle commuter. It is worth identifying three main groups here: non-riders, occasional riders, and then commuter cyclist and regular recreational riders. There are other groups of people involved in competitive cycling, such as road-racing or technical mountain bike riding, and touring cyclists, but these people have separate and specific barriers and motivations.

The following table considers those factors that influence people who cycle for recreation and for transport. These influences are grouped by whether they are individual, social, cultural or economic factors, and environmental factors. Sometimes the same variable can have one dimension that is a barrier, and yet may also be a motivating factor. For example, for a non-cyclist getting fit/healthy can be a significant reason to start riding, but at the same time the lack of fitness can make starting to ride an effort and the perception that cycling takes great effort serves as a barrier.

Safety concerns, often arising from the speed and volume of traffic and not having designated space for people riding bicycles, and aggressive driving has been consistently identified as deterrents to regular cycling (Greig, 2001). It is worth noting that concerns about safety are higher among non-cyclists than regular riders (Rissel et al, 2002), with non-cyclists consistently overestimating the level of risk involved. People with varying levels of cycling experience perceive traffic safety differently. Based on qualitative research with women, Garrard (2003) suggests that this it is more to do with skills, self-confidence, experience and route familiarity – when these increase, traffic safety concerns decrease.

Table 1: Influences on cycling

Influences	Includes	Specific factors	
		Recreation	Transport
Individual factors	Demographic	Age, gender, health status, SES	Age, gender, health status, distance, SES
	Personal: motivation/initiation	Health, fitness, other people, campaigns, events, information, skills, resources, challenge, social encouragement, support to address safety concerns, time availability/priority	Cost, convenience, health, fitness, incentives, environmental concerns, other people, support to address safety concerns, time availability
	Personal: maintenance	Fun, enjoyment, self-efficacy, achieve cycling goals, acquire skills,	Above, plus, establishing a routine that works (eg safe

		experience, community links (eg cycling groups) Sense of control over safety	route, carrying things, change facilities, bike security), sense of control over safety
Social/ cultural/ economic factors		Family/social 'time together' Values (eg encouraging children to be active) Cost (relatively low, but requires bike and helmet)	Normative transport behaviour Driver behaviour 'Invisible infrastructure' (eg traffic calming) Cost and convenience of alternatives (eg cost of petrol) Population density Destinations of interest
Environmental factors	Natural environment Built environment	Easy access to pleasant surroundings, geography Cycling facilities (off-road paths), amenities	Weather, geography On and off-road paths, urban design, end-of-trip facilities

Greig (2001) identified a number of predisposing factors that negatively impact on cycling. These are important to identify, in order that strategies can be developed that address them. These negative predisposing factors are the belief that cycling is dangerous, the perception that great effort is required, the reaction to compulsory helmet wearing, limited secure storage, not being aware of improved cycle ways, or the perception that cycling is something you do before you start driving. The fitness image of cyclists (for example, athletes or wearing lycra) can also be a barrier to those people who do not currently cycle.

The degree of effort required to get to a cycle path is also related to whether a cycle path is used. In a study in Western Sydney, those people who owned a bicycle and were living close to a cycle path were more likely to use it than bicycle owners living 1.5 kilometres from the path (Merom et al, 2003).

Australian Interventions to promote cycling

Seventeen Australian programs with a component to increase cycling published since 1995 with an evaluation component have been included in Table 2 below. The program title and first author and year of publication is given, followed by a brief summary of the main strategies used and results found. An assessment of the level of evidence provided by the evaluation is given according to the following hierarchy of evidence:

I Evidence obtained from a systematic review of all randomised control trials (RCT)

II Evidence obtained from at least one properly designed RCT

III-1 Evidence obtained from well-designed pseudo-RCT (alternative allocation or some other method)

III-2 Evidence obtained from comparative studies with concurrent controls and allocation not randomised (cohort studies), Case control studies or interrupted time series with a control group

III-3 Evidence obtained from comparative studies with historical control, two or more single arm studies or interrupted time series without a parallel control group

IV Evidence obtained from case series, either post-test or pre test and post test

This hierarchy of study designs (commonly referred to as "levels of evidence") is used by the National Health and Medical Research Council (NHMRC, 2000) to indicate the increasing potential for bias in those studies on lower levels, and therefore the greater reliance on the conclusions from those higher rated studies. However, it is also important to recognise that this hierarchy disadvantages research study designs where the subject of interest is communities, policies, or local governments or other complex social phenomenon. It is very expensive to randomly allocate whole local government areas to treatment and control conditions and community interventions are relatively rare in the public health literature. It is also important to note that in some public health settings it may only be feasible, or politically and/or ethically acceptable to conduct observational studies (Rychetnik and Frommer, 2004). Evaluation opportunities that arise through policy or infrastructure changes can create natural experiments that can provide relevant and useful 'real life' data (Petticrew et al, 2005).

There are certainly more programs seeking to promote cycling in Australia than are reported here, although many of these are not being formally evaluated or the results of evaluations that have been conducted have not been documented, or the documentation of these evaluations are not readily accessible to external agencies. The level of evidence of the effectiveness of the various strategies to promote cycling provided by the available published reports is relatively low, consistent with previous international reviews (Ogilvie et al, 2004). However, this is more a reflection of the inadequacies of the traditional bio-medical evidence hierarchy in assessing the types of interventions needed to promote cycling in a variety of settings. Almost all of the identified cycling promotion program evaluations have shown some degree of increase in cycling, suggesting that if they were to be implemented on a wider scale and with adequate resources they would lead to increases in population levels of regular cycling.

Discussion

This review has highlighted the relatively low level of regular cycling for transport in Australia, and the marked gender disparity of riders. However, cycling is a very popular recreational activity (fourth most popular nationally), suggesting that under favourable conditions some of these riders could substitute short car trips for bicycle trips. This review has also highlighted the variety of personal, social and environmental influences on cycling, which are more or less influential depending on where on the continuum of cycling development a person might be.

Achievable cycling targets

In thinking about the factors that influence people to ride a bicycle, it is important to remember that even in those European cities where cycling is a common mode of transport, the highest proportion of trips by bicycle is around 45 per cent of all trips (Anderson 2005). There are some circumstances where using a bicycle is not an option. First, there is a time/distance barrier for a journey, beyond which it is not an option to use a bicycle. While this point will vary depending on the level of cycling enthusiasm, between 30-60 minutes is a general limit for the majority of the population.

Second, certain commitments will impact on the ability to use a bicycle. For example, carrying heavy or bulky items reduces the feasibility of cycling, as do other choices, such as walking to school with a child or taking an elderly relative shopping which then intrudes on the time/distance barrier.

Third, a certain proportion (10%) of the population will be physically unable to ride a bike because of a physical disability – between 5.2% (severe or profound core activity restriction) to 15.3% (one or more activity limitations or restrictions or participation restrictions), and this increases in older populations(AIHW, 2003). Lack of physical fitness or even adequate physical activity affects almost half the population, which reduces the time/distance able to be cycled.

Finally, not having access to a bicycle is a critical determinant of cycling behaviour. Approximately 40 per cent (39%) of Sydney households have access to a bicycle (Transport Data Centre, 2003). with Sydney having the lowest level of bicycle ownership in Australia at 29 per cent, compared with bicycle ownership in Canberra at 65 per cent (Australian Bicycle Council, 2004).

Recommendations for research and practice

This review has highlighted the relative paucity of research and evaluation studies concerned with the promotion of cycling. Given the lack of evaluation data, there are many aspects of cycling that require research and evaluation. The main areas of work identified in our review are summarised below, but these are not intended to be comprehensive.

- Implement and evaluate advocacy strategies to increase political commitment and will to support cycling, and increase the profile of everyday cycling among policy and decision makers;
- Regular and systematic national and state assessment of cycling frequency and prevalence, such as outlined in the Cycling Data and Indicator Guidelines (Australian Bicycle Council, 2000);
- Document/evaluate the effects of 'invisible' infrastructure on cycling prevalence and safety, such as lower speed limits and traffic calming;
- Document/evaluate the effects of off- and on-road cycling infrastructure, and its promotion;
- Better access to documents / understanding of the individual, normative, and social factors that facilitate or hinder cycling;
- Better understanding and documentation of the role of 'road rage', poor driver behaviour and 'safety concerns' on cycling prevalence;
- Research to explore whether increases in cycling leads to overall

increases in levels of physical activity;

- Clearinghouse role for the Australian Bicycle Council (or similar) for reports on cycling and evaluations of strategies to promote cycling; and
- Bicycle advocates/researchers need to document better the effective strategies for promoting cycling.

Conclusions

From the published evaluation studies located, it is clear that there are very few high quality Australian evaluations as defined by biomedical research standards, although the number of such reports and publications have increased substantially in the last five years. Despite this lack of evidence, there has been a small but sustained increase in the prevalence of cycling over recent years, particularly in the inner state capital city areas. There are many examples of small projects that have increased cycling, or improved the conditions for cycling, and many examples from other countries. The absence of control groups is not necessarily an evaluation limitation, as the prevailing cycling trends are declines or no change. The best available evidence indicates that the investment in cycling infrastructure AND promotion successfully encourages cycling. It is also clear from data on frequency of recreational cycling that a great many people want to ride bicycles. However, despite the multiple benefits of cycling across many sectors, political support and financial commitment to cycling are required to increase the prevalence of cycling.

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Table 2: Australian interventions to promote cycling by setting and intervention type

Intervention type	Setting/population			
	School	**University**	**Workplace**	**Community-wide**
Education/skills	Bike Education program *(Carlin, Taylor and Nolan, 1998)* Strategy: School based curriculum program with skills component. Results: Increase in injuries in the intervention group Evidence level: III-2			Adult skills group *(Telfer et al, in press)* Strategy: 6 hours of group instruction, mostly learning cycling skills and ride practice Results: An 40% increase in weekly cycling time among those not-riding at baseline Evidence level: III-3
	CARES program *(Baker, 2005)* Strategy: Purpose built training venue for skills development, plus classroom component Results: Decrease in injuries in intervention group (12% v 22%) Evidence level: III-2			
Social marketing/ behaviour change		Monash Travel Smart *(Cooper and Meiklejohn, 2003)* Strategies: Travel behaviour change media promotion among students Results: Observed increases in cycling Evidence level: III-3	Health workforce intervention *(Wen et al, 2005)* Strategies: Individual travel behaviour change interviews with a cohort of staff, plus general social marketing strategies Results: Reduced car use, but no change in cycling level Evidence level: III-3	Adelaide project (Rose and Ampt, 2001) Strategies: individual action program, known as Travel Blending®, involves participating households being sent a series of four kits, containing information booklets and travel diaries, over a nine-week period Results: a 10% reduction in car driver kilometres Evidence level: III-3
			Ride to Work Day *(Marfut et al, 2005)* Strategies: Ride to work event advertised widely through workplaces Results: 13% rode to work for	Event series data analysis *(Garrard and Crawford, 2005)* Strategies: Secondary data analysis Results: Increase in event participation over time

			the first time, and a quarter of these people were still riding to work five months later Evidence level: III-3	Evidence level: IV
				Hawthorne Canal Project *(Ashley and Rissel, 2004)* Strategies: Distribution and promotion of local cycling map illustrating key connections, plus organised community rides Results: Bicycle counters indicated an increase in use of highlighted route Evidence level: III-3
				Bike event days *(Zaccari, 2004)* Strategies: Bike days organised by local council, including a family ride Results: Similar level of participation each year Evidence level: IV
Infrastructure				Cycle monitoring in Victoria *(Bicycle Victoria, 2003)* Strategies: Data analysis of bicycle counters at key strategic routes Results: Steady increase in bike counts Evidence level: III-3
				Western Sydney Rail Trail Evaluation *(Merom et al, 2003)* Strategies: Completion of new dedicated bicycle infrastructure, but minimal promotion Results: Small but statistically significant increase in use of facility Evidence level: III-2
'Invisible infrastructure' (eg traffic calming policies, fiscal policies such as congestion taxes, petrol prices)	No Australian data			

Multi-component			Cycling 100 *(Marshall, 2001)* Strategies: Employees committed to replacing 4 car trips per week by bicycle and were given use of a free bicycle Results: Significant improvements in a range of health indicators Evidence level: III-3	Cycle Instead program *(Greig, 2001)* Strategies: Media and community intervention Results: Significant increase in the proportion of respondents who had cycled in the previous six months (28% vs 36%) plus bike counters showed an overall increase of 68.2% of cyclists. Evidence level: III-3
			Cycling in the city *(Kuiper, 2005)* Strategies: Employees at three workplaces committed to riding to work on two days a week were given cycling skills training and social supportuse within the workplace. Results: Increase in employees regularly riding Evidence level: III-3	Cycle Instead Shepparton *(Bicycle Victoria, 2004)* Strategies: Media and community campaign over two months Results: 39% increase in cycling after two months Evidence level: III-3
				TravelSmart South Perth *(James, 2002; Ashton-Graham, 2002; Department of Infrastructure, 2003)* Strategies: In-depth interviews with households about travel behaviour change Results: 61% increase in cycle trips Evidence level: III-2