Health Promotion International Advance Access published October 22, 2009

Health Promotion International
doi:10.1093/heapro/dap041

Cyclists' attitudes toward policies encouraging bicycle travel: findings from the Taupo Bicycle Study in New Zealand

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SUMMARY

Utility cycling provides substantial health, environmental and economic benefits. Despite a favourable trend in leisure-time cycling, cycling is infrequently used for everyday travel needs in New Zealand. This study investigated cyclists' attitudes toward environmental and policy measures that would encourage them to cycle more, particularly for a trip to work. A cross-sectional analysis was undertaken using baseline data obtained from the Taupo Bicycle Study, a web-based longitudinal study. The study population comprised 2469 cyclists, aged 16 years or over, who had enrolled in the 2006 Wattyl Lake Taupo Cycle Challenge. The majority (88%) reported the provision of bicycle lanes as an important factor that would encourage them to cycle more often, followed by bicycle paths (76%), better bicycle security (64%), reduced motor vehicle speed (55%) and bike friendly public transport (38%). Of those who reported travelling to work at least once a week (N = 2223), varying proportions reported shower facilities at work (61%), fewer difficult intersections (43%), rising fuel costs (41%), fewer car parks (27%), bike designed to commute (26%) and rising cost of car parking (25%) as important factors that would encourage them to cycle to work more often. There were important differences in these perceived influences defined by the participants' socio-demographic characteristics and current cycling habits.

Key words: bicycling; transportation; work; public policy

INTRODUCTION

Active travel increases levels of physical activity and provides significant health benefits (Colditz *et al.*, 1997; Hamer and Chida, 2008). Some studies suggest that cycling confers greater benefits than walking due to the increased intensity of effort and longer distances covered (Oja *et al.*, 1998; Ming Wen and Rissel, 2008). A Danish study reported that mortality rates were 28% lower among those who cycled to work compared with those who did not after adjusting for leisure time physical activity (Andersen *et al.*, 2000). Similar evidence links such benefits with utility cycling among Chinese women (Matthews *et al.*, 2007). While the risk of bicycle-related injuries and deaths is well-documented, the health benefits gained from regular cycling are likely to outweigh such risk (British Medical Association, 1992). In addition, cycle commuting enhances

social cohesion, improves road safety, reduces urban air pollution and saves fuel.

Despite this, cycling in many high income countries is a marginal mode of transport. In New Zealand, bicycle use represents only 1% of the overall travel mode share (Ministry of Transport, 2008) and 3% of all trips under 2 km (O'Fallen and Sullivan, 2009). The prevalence of cycle commuting to work has fallen over the last two decades; only 2.5% of the population who travelled to work used a bicycle in 2006 (Statistics New Zealand, 2007), compared with 5.6% in 1986 (Department of Statistics, 1987). In contrast, there is a favourable trend for leisure-time cycling (Sport & Recreation New Zealand, 2007). As work-related travel accounts for one-third of all household driving time and distance (Ministry of Transport, 2007) and nearly half of vehicle driver trip chains are potentially cyclable (i.e., less than 6 km in length) (O'Fallen and Sullivan, 2009), there are opportunities to convert enthusiasm for recreational cycling to utility cycling.

This study investigated cyclists' perceptions of the environmental and policy measures that would encourage bicycle travel in general and cycling to work in particular, and the factors associated with cyclists' preferences.

METHODS

Design, setting and participants

This is a cross-sectional analysis of baseline data collected in the Taupo Bicycle Study, a web-based longitudinal study (Thornley *et al.*, 2008), designed to examine factors associated with the risk of cycling injuries and barriers and enablers to cycling regularly. The sampling frame comprised cyclists, aged 16 year and over, who enrolled in the 2006 Wattyl Lake Taupo Cycle Challenge, New Zealand's largest mass cycling event held each November. The participants' experience varied from competitive sports cyclists and experienced social riders to relative novices of all ages. Cyclists who provided email addresses at enrolment were invited to participate in this study and two prizes toward a bicycle purchase were offered as incentives. Of the 5653 cyclists invited, 3998 (70.7%) agreed to take part in the study and 2469 (43.7%) completed the questionnaire. Ethical approval was obtained from the University of Auckland Human Participants' Ethics Committee.

Measures

Before the Cycle Challenge, baseline information was collected about participants' self-reported socio-demographic characteristics, general cycling activity over the preceding year, cycling experience, desire to cycle more than at present and use of a bicycle for a trip to work. All participants were asked to rate the importance of specified factors that would encourage them to cycle more often—more bicycle lanes (adjacent but not separated from motorized traffic), more bicycle paths (separated from motorized traffic), bike friendly public transport, reduced vehicle speed and better cycle security in public places—and factors that would encourage them to cycle to work more often—rising costs of petrol, rising costs of car parking, fewer car parks, fewer difficult intersections, bikes designed to commute and access to shower facilities at work. The response options were: 'extremely important'; 'very important'; 'important'; 'somewhat important'; 'not very important'; and 'not important at all'. The questions sought information on aspects of the traffic environment in New Zealand most amenable to influence from national and/or local government policy makers.

The addresses of participants were aggregated into meshblocks, the smallest geographic areas containing an average of 100 people and 40 dwellings (Statistics New Zealand, 2002), using Geostan^{TM} (Pitney Bowes Group 1 Software). The meshblocks were then categorized as 'main urban area', having an average population density of 522.8 people per square kilometre, or others (Statistics New Zealand, 2005). The levels of neighbourhood deprivation were assessed by the 2001 New Zealand Deprivation Index (NZDep) (Salmond and Crampton, 2002). Decile ten is deemed the most deprived and decile one the least.

Statistical analysis

Following descriptive analyses, unconditional logistic regression was used to predict cyclists' perceptions of the measures described above. Each dependent variable was dichotomized into 'important' (i.e. somewhat important, important, very important and extremely important) and 'not important' (i.e. not very important and not important at all) in the first model and into 'extremely important' and 'not extremely

important' (i.e. all other responses) in the second model. All covariates found to be significantly associated with policy measures were included in the multivariate models. SAS (release 9.1, SAS Institute Inc., Cary, NC) was used for all analyses.

RESULTS

The mean age of participants was 44 years and 1811 (73%) were male (Table 1). Compared with the national population (Statistics New Zealand, 2007), the sample had a higher proportion of non-Maori (96 versus 85%) and university graduates (53 versus 14%). The majority were from main urban areas (77 versus 72%) and from less-deprived neighbourhoods (51% in NZDep deciles 1–3). The participants had mean cycling experience of 7 years and cycled three times a week on average. About 75% of the participants reported that they wanted to cycle more than at present and 29% reported cycling to work at least once a week.

Perceived importance of factors that would encourage bicycle travel

In decreasing order of frequency, participants reported more bicycle lanes, more bicycle paths, better bicycle security in public places, reduced vehicle speed and bike friendly public transport as important factors that would encourage them to cycle more often (Figure 1). Table 2 shows the multivariate effect estimates for factors that at least 40% of cyclists perceived as important in this regard. Female cyclists were more likely to report the importance of all factors while age groups over 35 years were more likely to report the importance of 'more bicycle paths'. The perceived importance of 'better bicycle security in public places' was lowest among university graduates and particularly high among cyclists living in more deprived neighbourhoods. The latter group and those living in urban areas were more likely to support 'more bicycle lanes' and 'more bicycle paths'. Cycling to work was significantly associated with all factors except 'more bicycle paths'; and the desire to cycle more often with 'reduced vehicle speed'.

Table 1: Participant characteristics

Variable	Total ($N = 2469$), N (%)	Participants who reported travelling to work ($N = 2223$), N (%)
Personal characteristics		
Age group		
16–35	545 (22.1)	511 (23.0)
36–50	1280 (51.8)	1183 (53.2)
50+	644 (26.1)	529 (23.8)
Gender		
Male	1811 (73.4)	1649 (74.2)
Female	658 (26.6)	574 (25.8)
Ethnicity		
Maori	104 (4.2)	97 (4.4)
Non-Maori	2365 (95.8)	2126 (95.6)
Highest education level		
High school (secondary) or less	524 (21.3)	455 (20.5)
Polytechnic	627 (25.5)	553 (24.9)
University	1312 (53.3)	1214 (54.6)
Residential characteristics[a]		
NZDep index of residing meshblock (deciles)		
1–3	1225 (51.4)	1101 (51.5)
4–7	815 (34.2)	732 (34.2)
8–10	344 (14.4)	307 (14.4)
Area of residence		
Main urban area	1846 (77.4)	1689 (78.9)
Others	540 (22.6)	453 (21.1)
Cycling characteristics		
Cycling experience (years)		
0–2	1043 (42.4)	931 (42.1)
3–7	714 (29.1)	645 (29.1)
≥8	701 (28.5)	638 (28.8)
Frequency of cycling per week		
0–1	383 (15.6)	352 (15.9)
2–4	1185 (48.2)	1065 (48.0)
≥5	890 (36.2)	800 (36.1)
Expressed desire to cycle more		
Yes	1834 (74.6)	1678 (75.8)
No	623 (25.4)	537 (24.2)
Cycling to work at least once a week		
Yes	717 (29.4)	712 (32.2)
No	1722 (70.6)	1499 (67.8)

[a]There were missing values for participants who provided a PO Box or overseas address.

Perceived importance of factors that would encourage cycling to work

Analyses were restricted to 2223 cyclists who reported travelling to work at least once a week. The demographic distribution of this group was similar to the overall sample (Table 1). The participants reported (in decreasing order of frequency) that access to shower facilities at work, the need to negotiate fewer difficult intersections, rising costs of petrol, fewer car parks,

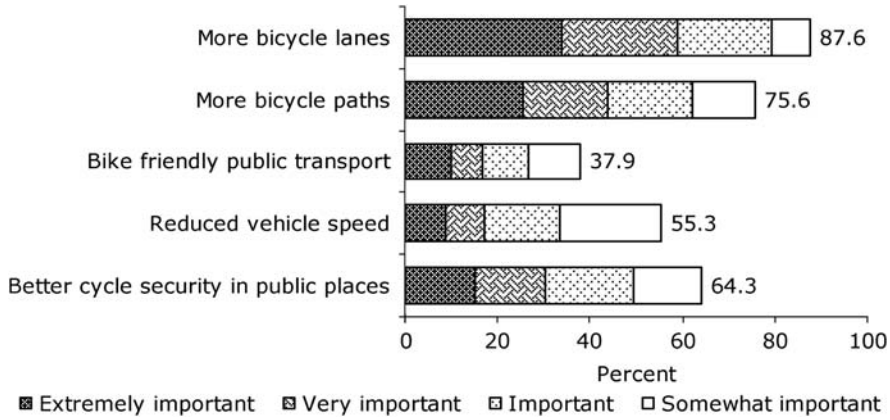

Fig. 1: Factors perceived as important in encouraging bicycle travel ($N = 2469$).

bikes designed to commute and rising costs of car parking would be important incentives to cycle to work (Figure 2). Table 3 shows the multivariate models for those factors that at least 40% of cyclists perceived as important in this regard. Female cyclists were more likely to report the importance of all factors; younger cyclists were more likely to report the importance of 'rising fuel costs'; and participants with high school or less education were more likely to report the extreme importance of 'rising fuel costs' (Table 3). Participants living in urban areas were more likely to support all factors except 'rising fuel costs'. Cycling to work was significantly associated with all factors except 'access to shower facilities at work'; frequency of cycling with 'rising fuel costs'; and desire to cycle more often with 'access to shower facilities at work'.

DISCUSSION

This study demonstrates the perceived importance of several feasible or modifiable environmental and policy measures to encourage more frequent cycling and cycling to work in a cohort of people taking part in a large cycling event. Most respondents identified bicycle lanes, bicycle paths, better cycle security in public places, shower facilities at work and reduced vehicle speed as important incentives. These measures were supported more often than approaches designed to restrict reliance on private motor vehicles.

This is one of very few studies examining attitudes toward policies that encourage bicycle use, but the findings should be interpreted with caution given several limitations. First, the study population and high attrition rate in completing the questionnaire is likely to have resulted in a study sample that is at the 'more active' end of the bicycling spectrum although the participants reported a wide range of week to week cycling activities. Second, web-based data collection limited the study sample to cyclists who provided email addresses to event organizers. However, with this design, we efficiently recruited more participants than would have been possible with conventional postal questionnaires. Third, the measures were self-reported and there is a potential for bias, for example, in socially desirable responses (such as the amount cycled) and in participants' subjective ratings of the importance of factors that may influence their cycling behaviour. Fourth, the survey did not cover more complex policy measures such as urban design. A recent study involving 364 Auckland residents found that commuting distance and street connectivity were associated with transport-related physical activity (Badland *et al*., 2008). Likewise, free text entries recorded by our participants suggest that distance and/or time were additional factors influencing the likelihood of cycling to work. Finally, this analysis did not explore perceptions of safety and traffic congestion, important determinants of travel behaviour that could be incorporated in future interventions.

Despite such limitations, our findings help prioritize efforts to promote cycling and identify

Table 2: Predictors of perceived importance of factors that would encourage bicycle travel ($N = 2469$)

Predictors	*N*	Important[a]		Extremely important	
		%	Adjusted OR[b] (95% CI)	%	Adjusted OR[b] (95% CI)
More bicycle lanes					
Gender					
Male	1811	85.9	1.00	30.9	1.00
Female	658	92.3	**2.13 (1.53–2.95)*****	42.0	**1.79 (1.47–2.17)*****
Area of residence					
Main urban area	1846	89.6	**2.14 (1.63–2.80)*****	35.6	**1.57 (1.26–1.96)*****
Others	540	81.1	1.00	26.5	1.00
Cycling to work at least once a week					
Yes	717	91.3	**1.68 (1.24–2.28)****	38.7	**1.36 (1.12–1.64)***
No	1722	86.2	1.00	31.8	1.00
More bicycle paths					
Age group					
16–35	545	70.3	1.00	21.4	1.00
36–50	1280	75.6	**1.41 (1.12–1.78)***	26.4	**1.43 (1.12–1.83)***
50+	644	80.2	**2.04 (1.53–2.71)*****	26.8	**1.58 (1.19–2.11)***
Gender					
Male	1811	73.7	1.00	22.8	1.00
Female	658	81.1	**1.77 (1.40–2.24)*****	32.6	**1.79 (1.45–2.20)*****
Area of residence					
Main urban area	1846	77.7	**1.64 (1.32–2.04)*****	26.8	**1.49 (1.17–1.88)***
Others	540	69.3	1.00	20.7	1.00
Better bicycle security in public places					
Age group					
16–35	545	69.9	1.02 (0.78–1.34)	16.5	[c]
36–50	1280	62.2	0.80 (0.64–0.99)	15.5	
50+	644	63.4	1.00	13.1	
Gender					
Male	1811	59.6	1.00	12.4	1.00
Female	658	76.9	**2.52 (2.02–3.14)*****	22.5	**2.19 (1.72–2.79)*****
Highest education level					
High school (secondary) or less	524	70.5	**1.65 (1.31–2.08)*****	18.2	**1.55 (1.16–2.07)***
Polytechnic	627	65.3	**1.33 (1.08–1.64)***	16.6	**1.38 (1.05–1.82)**
University	1312	61.2	1.00	13.3	1.00
NZDep index (deciles)					
1–3	1225	60.2	1.00	12.2	1.00
4–7	815	69.2	1.11 (0.91–1.35)	16.5	**1.34 (1.04–1.74)**
8–10	344	65.2	1.08 (0.83–1.41)	18.8	**1.80 (1.31–2.49)****
Frequency of cycling per week					
0–1	383	60.4	1.00	13.8	[c]
2–4	1185	62.8	1.12 (0.87–1.44)	13.6	
≥5	890	67.4	1.25 (0.95–1.64)	17.6	
Cycling to work at least once a week					
Yes	717	72.9	**1.82 (1.46–2.26)*****	19.6	**1.71 (1.34–2.19)*****
No	1722	60.6	1.00	13.3	1.00
Reduced vehicle speed					
Gender					
Male	1811	50.1	1.00	6.5	1.00
Female	658	69.8	**2.37 (1.95–2.88)*****	14.7	**2.49 (1.85–3.33)*****
Expressed desire to cycle more					
Yes	1834	57.2	**1.36 (1.13–1.65)***	9.4	**1.45 (1.01–2.09)**
No	623	49.8	1.00	6.6	1.00
Cycling to work at least once a week					
Yes	717	59.9	**1.37 (1.14–1.64)****	10.4	**1.46 (1.08–1.99)**
No	1722	53.5	1.00	7.8	1.00

[a]Includes 'somewhat important', 'important', 'very important' and 'extremely important'.
[b]Adjusted for all other variables in the model.
[c]Not significant in univariate models.
*$P < 0.01$, **$P < 0.001$, ***$P < 0.0001$.

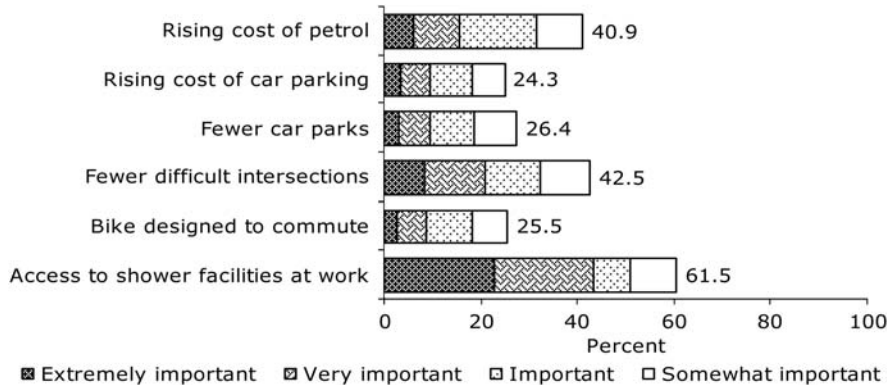

Fig. 2: Factors perceived as important in encouraging cycling to work ($N = 2223$).

subgroups most amenable to such efforts. In a recent survey involving 460 Oklahoma residents, two-fifths of the respondents strongly supported and one-fifth somewhat supported creation of 'bicycle ways' (Heesch and Han, 2007). The odds were greater for respondents who lived in metropolitan areas; who walked or cycled for transport in the previous month; who preferred to walk for transportation; or who had attitudes in favour of cycling or walking. In earlier US surveys, more than four-fifths of respondents supported zoning regulations favouring walking or bicycle paths with greater odds observed among female respondents, those who reported leisure time physical activity and those with higher outcome efficacy (Brownson *et al*., 1998, Brownson *et al*., 2001).

In our study, female respondents were more likely to consider the specified measures as important, the gender differences being most apparent for factors relating to motor vehicle speed, difficult intersections and fuel costs. The perceived importance of particular measures did not significantly differ across broad age groups with the exception of bicycle paths (perceived as more important by older cyclists) and rising fuel costs (which particularly influenced younger cyclists). Respondents whose highest educational qualification was high school or less were more likely to consider improved bicycle security and rising fuel costs as important influences. Cyclists in main urban areas (compared with other areas) were more likely to support modifications to the road environment (e.g. more bicycle lanes, more bicycle paths and better designed traffic intersections). Not surprisingly, participants who already cycled to work (compared with those who did not) were more likely to express the importance of more bicycle lanes, reduced vehicle speed, fewer intersections, better bicycle security, provision of shower facilities at workplaces and rising fuel costs.

More respondents in our survey expressed support for bicycle lanes adjacent to motorized traffic compared with separated bicycle paths. A US national survey showed that people who cycled more frequently preferred bicycle lanes, whereas infrequent cyclists favoured more bicycle paths (Bureau of Transportation Statistics, 2004). Others have found that cyclists are not safer on bicycle paths than on roads due to the risks that apply at intersections (Garder *et al*., 1994; Elvik and Vaa, 2004; Jensen, 2007). Various intersection treatments have been tested in recent years and modifications such as pavement markings, coloured bicycle crossings, advanced stop lines, bicycle scramble and bicycle-only signal phases have been shown to reduce cyclist–motorist conflicts (Weigans, 2008).

Many other local factors may influence decisions to enhance cycling and the safety of cyclists (Godefrooij, 1997). For example, bicycle paths may be desirable for transport environments with heavy and/or fast traffic flows, narrow roadways, high parking turnover and high prevalence of vulnerable road users such as child and elderly cyclists. In residential streets where it is not feasible to provide separate cycling facilities, policies to reduce vehicle speeds may be necessary. Other approaches include provision of secure bicycle parking and restriction of car use. Over half of the participants

Table 3: Predictors of perceived importance of factors that would encourage cycling to work ($N = 2223$)

Predictors	*N*	Important[a]		Extremely important	
		%	Adjusted OR[b] (95% CI)	%	Adjusted OR[b] (95% CI)
Access to shower facilities at work					
Age group					
16–30	511	67.4	1.31 (0.99–1.73)	26.5	[c]
31–50	1183	60.3	1.03 (0.82–1.29)	22.7	
50+	529	58.0	1.00	22.5	
Gender					
Male	1649	58.4	1.00	21.0	1.00
Female	574	70.0	**1.73 (1.38–2.15)*****	30.5	**1.67 (1.33–2.10)*****
Area of residence					
Main urban area	1689	64.9	**2.10 (1.69–2.63)*****	25.2	**1.82 (1.37–2.42)*****
Others	453	47.7	1.00	16.1	1.00
Expressed desire to cycle more					
Yes	1678	63.1	**1.27 (1.03–1.57)**	24.7	1.27 (0.99–1.63)
No	537	56.5	1.00	19.9	1.00
Cycling to work at least once a week					
Yes	712	64.6	1.19 (0.98–1.45)	24.4	[c]
No	1499	59.9	1.00	23.1	
Fewer difficult intersections					
Age group					
16–35	511	48.3	**1.33 (1.01–1.76)**	11.2	1.55 (0.92–2.61)
36–50	1183	43.0	1.22 (0.97–1.55)	8.2	1.37 (0.86–2.21)
50+	529	35.4	1.00	5.1	1.00
Gender					
Male	1649	39.6	1.00	6.0	1.00
Female	574	51.0	**1.73 (1.40–2.14)*****	14.3	**2.76 (1.97–3.86)*****
Highest education level					
High school (secondary) or less	455	39.4	1.00	6.5	[c]
Polytechnic	553	38.6	0.88 (0.67–1.16)	7.2	
University	1214	45.4	1.07 (0.84–1.36)	9.2	
Area of residence					
Main urban area	1689	46.3	**2.28 (1.79–2.91)*****	9.2	**2.76 (1.62–4.71)****
Others	453	28.3	1.00	4.3	1.00
Expressed desire to cycle more					
Yes	1678	44.5	**1.40 (1.13–1.74)***	8.5	[c]
No	537	36.5	1.00	7.1	
Cycling to work at least once a week					
Yes	712	49.6	**1.58 (1.30–1.92)*****	10.6	**1.55 (1.11–2.17)**
No	1499	39.0	1.00	6.9	1.00
Rising cost of petrol					
Age group					
16–35	511	56.0	**1.88 (1.43–2.48)*****	9.5	**4.46 (1.94–10.22)****
36–50	1183	37.2	0.98 (0.78–1.24)	5.8	**3.45 (1.55–7.66)***
50+	529	33.5	1.00	1.8	1.00
Gender					
Male	1649	36.3	1.00	4.2	1.00
Female	574	53.7	**2.00 (1.62–2.47)*****	10.4	**2.58 (1.73–3.84)*****
Highest education level					
High school (secondary) or less	455	39.1	[c]	8.3	**1.89 (1.19–2.99)***
Polytechnic	553	40.8		4.7	0.91 (0.55–1.53)
University	1214	41.3		5.2	1.00
NZDep index (deciles)					
1–3	1101	38.5	1.00	4.4	1.00
4–7	732	45.5	1.17 (0.96–1.44)	7.5	0.83 (0.46–1.50)
8–10	307	40.2	0.96 (0.72–1.26)	5.7	1.26 (0.71–2.25)
Frequency of cycling per week					
0–1	352	41.0	[c]	2.7	1.00
2–4	1065	39.0		5.8	**2.10 (1.01–4.37)**
≥5	800	42.9		7.0	2.00 (0.93–4.30)

Continued

Table 3: *Continued*

Predictors	*N*	Important[a]		Extremely important	
		%	Adjusted OR[b] (95% CI)	%	Adjusted OR[b] (95% CI)
Cycling to work at least once a week					
Yes	712	53.4	**2.14 (1.76–2.61)****	9.9	**2.45 (1.61–3.71)*****
No	1499	34.6	1.00	3.8	1.00

[a]Includes 'somewhat important', 'important', 'very important' and 'extremely important'.
[b]Adjusted for all other variables in the model.
[c]Not significant in univariate models.
*$P < 0.01$, **$P < 0.001$, ***$P < 0.0001$.

in our study supported reduced vehicle speed and better bicycle security in public places as desirable strategies. In contrast, increasing fuel costs and restrictions on car parking were perceived as less important. This may reflect the relatively high socioeconomic status of the study sample or higher levels of resistance to car-restrictive measures. New Zealand is among the countries with the highest levels of car ownership. It has a dispersed population, low density cities and public transport systems that are poorly developed by European standards. Convenience of car use was identified elsewhere as one of the main reasons why New Zealanders do not cycle and walk (Cleland and Walton, 2004). In contrast to our findings, other sources of evidence indicate the potential effect of oil prices and parking policies in shaping travel behaviour (Hess, 2001; Schimek, 2007; Badland *et al*., 2009). Coordinated implementation of both incentive and restrictive measures has been responsible for the expansion of cycle commuting in European countries (Pucher and Buehler, 2008).

In addition to changes in road design and traffic flow, our findings indicate that the provision of showers in workplaces could increase the likelihood of cycling to work particularly among female, urban cyclists. Other measures that could be incorporated into workplace travel plans include the provision of pool bicycles, interest-free loans or other incentives to purchase bicycles and secure bicycle parking. While the provision of such facilities is not yet mandatory, a guide to assist workplaces in developing comprehensive travel plans has been published (Land Transport New Zealand, 2007).

To conclude, the majority of cyclists in our study supported the provision of cycling facilities over policies to restrict car use. The levels of support differed by participants' socio-demographic and cycling characteristics. While these findings may help prioritize policies tailored to enhance utility cycling by different subgroups of recreational cyclists, the coordinated implementation of these and other pro-cycling and car-restrictive measures will be needed to promote a modal shift from using cars to bicycles in the general population.

ACKNOWLEDGEMENTS

We acknowledge the support given to this study by the participating cyclists, the Lake Taupo Cycle Challenge organizers and the Clinical Trials Research Unit, University of Auckland.

FUNDING

This work was supported by the University of Auckland. Funding to pay the Open Access publication charges for this article was provided by the University of Auckland (Faculty Research Development Fund).

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