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Private and public modes of bicycle commuting: a perspective on attitude and perception

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Background: Public bicycle-sharing initiatives can act as health enhancement strategies among urban populations. The aim of the study was to determine which attitudes and perceptions of behavioural control toward cycling and a bicycle-sharing system distinguish commuters with a different adherence to bicycle commuting. **Methods:** The recruitment process was conducted in 40 random points in Barcelona from 2011 to 2012. Subjects completed a telephone-based questionnaire including 27 attitude and perception statements. Based on their most common one-way commute trip and willingness to commute by bicycle, subjects were classified into Private Bicycle (PB), public bicycle or Bicing Bicycle (BB), Willing Non-bicycle (WN) and Non-willing Non-bicycle (NN) commuters. After reducing the survey statements through principal component analysis, a multinomial logistic regression model was obtained to evaluate associations between attitudinal and commuter sub-groups. **Results:** We included 814 adults in the analysis [51.6% female, mean (SD): age 36.6 (10.3) years]. BB commuters were 2.0 times [95% confidence interval (CI) = 1.1–3.7] less likely to perceive bicycle as a quick, flexible and enjoyable mode compared to PB. BB, WN and NN were 2.5 (95% CI = 1.46–4.24), 2.6 (95% CI = 1.53–4.41) and 2.3 times (95% CI = 1.30–4.10) more likely to perceive benefits of using public bicycles (bicycle maintenance and parking avoidance, low cost and no worries about theft and vandalism) than did PB. **Conclusion:** Willing non-bicycle and public-bicycle commuters had more favourable perception toward public-shared bicycles compared to private cyclists. Hence, public bicycles may be the impetus for those willing to start bicycle commuting, thereby increasing physical activity levels.

Introduction

Automobile dependence is a global phenomenon in modern societies, even for short trip distances. Almost 50% of trips made in automobiles in Europe cover distances less than five kilometres (1). This despite the fact that commuting to work/school by car has been shown as positively associated with weight gain and obesity (2–4) due to its contribution to a sedentary lifestyle. Hence, the progressive substitution of private motor vehicles to active forms of transport for everyday commuting has become increasingly the focus of current urban transport and public health policies (5,6). Commuting actively by bicycle provides improvements in cardio-respiratory fitness and decreases the incidence of cardiovascular risk factors by intensifying the daily amount of cycling (7,8). Public bicycle-sharing programs have been presented as one means to address concerns of automobile dependency cultures due to their population-level promotion of regular physical activity (9,10). Such systems can also reduce automobile use (11,12) and ownership (11), although in European cities vehicle trips replaced by bicycle sharing may not exceed 10% (12,13).

Although many studies have focused on elements of the built environment as determinants of bicycle commuting, it has been reported that attitude and perception can be greater determining factors for an individual to commute actively than environmental variables (14–17), even though environmental factors facilitate the propensity to cycle and can also shape perceptions, especially those related to safety, convenience and speed of cycling (16–18). The theory of planned behaviour (TPB) (19) is a useful conceptual framework when evaluating cognitive approaches toward bicycle commuting (15,17). TPB states that attitude, subjective norm (defined as the perceived social pressure to perform or not a behaviour) and perceived behavioural control independently influence an individual's intention to perform a given behaviour (19). The TPB also states that this intention is the immediate antecedent of behaviour and that attitudes and perceived behavioural control influences behaviour indirectly by its effect on intention (19). In this study, attitude and perception of behavioural control toward the general performance of cycling and toward Bicing were evaluated.

Several European studies have assessed attitudes toward the bicycle as a mode of transport in working-age populations (20–22) and university settings (23–25). In-depth interviews comparing bicycle commuting attitudes between European and American commuters were also conducted (26). Attitudes toward public transport and environmental issues among 'members', 'prospective members' and 'persistent non-members' of a Chinese bicycle-sharing system have also been studied (27). To date, one study assessed motivations to increase the attractiveness of a bicycle-sharing service using focus groups (28), while another explored bicycle-sharing motivations in an adult sample and factors that influenced its frequency of use in a bicycle-sharing member's subsample (29). This study is novel because of the focus on both attitudes and perceptions of behavioural control toward cycling and bicycle sharing, and these are explored widely among commuters according to their degree of adherence to bicycle commuting.

Introducing interventions that have effects on attitudes and perceptions of behavioural control may modify travel behaviour indirectly (19). Bicycle sharing is filling an important niche in urban transportation systems facilitating multimodal one-way trips without the same costs and responsibilities than with private bicycle (30). Thus, it is important to assess the attitudinal profile of both public and private cyclists toward bicycle-sharing systems to better understand what influences an individual's modal choice. As little is known about attitudes and perceptions toward public bicycles for those non-bicycle commuters who are able to ride a bicycle (30,31), the identification of attitudes and perceptions of behavioural control of those commuters who are willing to commute by bicycle, especially those who use motorized commute modes, would therefore help to design more effective mobility, social and health intervention strategies. In addition, some studies have reported that psychological variables may have a greater influence on travel behaviour than the built environment, indicating that policies that improve local cycling conditions could be enhanced with campaigns targeted on attitudinal changes.

Methods

Design

As part of the Transportation, Air Pollution and Physical ActivitieS (TAPAS) project (http://tapas-program.org), we conducted a telephone-based questionnaire study on travel attitudes, perceptions and behaviour from June 2011 to May 2012 in Barcelona, Spain. It was designed to take approximately 30 min to complete and questions were both adapted from their original source and designed specifically for this study. The information collected in the questionnaire was pilot tested for local applicability and comprehension in a convenience sample of 36 participants and included weekly physical activity from the International Physical Activity Questionnaire (IPAQ) short form (32), common mode of transport (33), frequency and duration of travelling by bicycle from previous week (34), commuter travel behaviour, attitudes and perceptions (35) and socio-demographic indicators.

Context

Currently, 977 cities worldwide have a bicycle-sharing program in operation (36), such as the bicycle-sharing program of Barcelona (Bicing). After the introduction of Bicing in March 2007, the total length of bicycle lanes was extended by 30% from 2008 to 2011 (37). The same year Bicing was launched, the inner city's bicycle modal share increased by 36% when compared with 2006 (38) and reached 1.2% in 2007 (38). Despite these increases, at the time of the study (2011) the bicycle modal share was still a modest 2.2%. Private motorized transport, however, remains a prominent mode of transport for trips in the inner Barcelona municipality. In 2011, it represented 18% of all working-day trips, among which 52% were made by automobile and 34% by motorcycle (37).

Site selection and subjects

A street-based recruitment strategy was conducted in four random points within each of the ten districts of Barcelona. Each of these points was sampled from 07:45–11:30 AM in 4 weekdays by three trained interviewers. They were randomly assigned to a strategic location to cover all transportation modes: public transportation stations, private motorized parking lots and bicycle parking. Before being invited to fill out a travel survey, subjects were given initial screening questions to determine whether they were commuters or not. As reported by Rojas-Rueda et al. (9), the mean distance of a Bicing trip in 2009 was 3.29 km, equivalent to 14 min at an average cycling speed of 14 km/h or 20 min at a cycling speed of 10 km/h. Hence, to ensure commuters susceptible to commuting by bicycle were included, it was reasonable to include those commuters physically able to ride a bicycle for 20 min. Respondents had to meet the following inclusion criteria: (i) being 18 years or older; (ii) currently living and having lived since 2006, in Barcelona; (iii) currently working or studying in Barcelona; (iv) being physically able of riding a bicycle for 20 min; (v) having a work/school address more than 10 min walk from home and (vi) commuting by modes other than only walking. Of the 6701 subjects who accepted to answer screening questions, 1508 met the inclusion criteria and 871 subjects completed the survey. After being surveyed, 57 subjects were excluded due to not truly meeting the inclusion criteria, leaving 814 subjects for analysis.

The protocol was approved by the Clinical Research Ethical Committee of the Parc de Salut Mar (CEIC-Parc de Salut Mar) and written informed consent was obtained from all subjects.

Study variables

Subjects were asked for their most common one-way trip mode to work or school. Those who reported using a private bicycle during their unimodal or multimodal commuting trip were defined as Private Bicycle (PB) commuters, whereas those who reported Bicing were defined as Bicing Bicycle (BB) commuters. Non-bicycle commuters were asked for their willingness to use a bicycle for all or part of their commute trip. Those who answered they were willing or totally willing were defined as Willing Non-bicycle (WN) commuters, and those who answered unwilling or totally unwilling were defined as Non-willing Non-bicycle (NN) commuters. It was hypothesized that private bicycle commuters would have the highest degree of adherence to bicycle commuting and the ones with the most favourable attitude toward cycling.

Attitude was defined as the positive or negative value that a commuter associates with cycling and Bicing and perception of behavioural control as the perceived benefits and barriers that a commuter may consider when cycling and using Bicing. Both were evaluated through 27 survey statements (with 19 regarding cycling and eight regarding Bicing). Responses for all of these statements were measured on a four-point scale, ranging from strongly disagree to strongly agree.

Commuting distance and neighbourhood deprivation index (39) were processed with Geographic Information System software using self-reported home and work/school addresses (see Supplementary Material for more details of above methods).

Statistical analysis

Chi-square and Kruskal–Wallis tests were performed for the descriptive statistics. To study the relationship between attitude and perception statements and commuters' sub-groups, chi-square and Fisher's exact tests were applied.

All 27 survey statements were then reduced through an exploratory multivariate analysis into attitudinal components using the method of principal component analysis (PCA) with an orthogonal rotation. As PCA considers only complete cases, we used multiple imputations to replace missing values in covariates. We created 100 imputations, generating 100 complete datasets. The distributions of all variables were similar for observed and imputed data (Supplementary Tables S2 and S3) and the significance of results did not change after sensitivity analysis.

A multinomial logistic regression model was then developed to assess differences among commuters regarding attitudinal components. All variables that in bivariate analysis showed a statistically significant relationship with both type of commuter and attitudinal sub-group at $P < 0.25$ level were included in the multivariate analysis. The final multivariate model included only those variables that were statistically significant at $P < 0.05$ and gender and age regardless of statistical significance. A Small–Hsiao test of the assumption of the independence of irrelevance alternatives verified the independence of all commuter sub-groups.

All analyses were performed using the statistical package Stata v.12.1.

Results

Sample characteristics

As listed in table 1, subjects were largely females (51.6%), Spanish (87.2%), workers (87.0%) and had normal BMI indices (73.1%). All had at least a primary education, with 89.8% of subjects having at least secondary and 61.6% university education.

PCA on survey statements

Seven components were obtained from the PCA, explaining 58% of the total variance observed. Kaiser–Meyer–Olkin measure was 0.80, showing the adequacy of this method in our dataset. Labels for each component were inspired by the ones used by Heinen et al. (22) and are shown in tables 2 and 3. See component loadings of each survey statement in Supplementary Tables S3 and S4, Tables S1a and S1b.

Benefits and barriers of cycling

Pairwise correlations showed statistically significant differences between PB and BB only for flexible (96% vs. 87% in BB) and

Table 1 Individual and household characteristics associated with bicycle commuting in the city of Barcelona (2011-12) before multiple imputations

	All N = 814	Bicycle commuters n = 374		Non-bicycle commuters n = 440		P[b]
		PB[a] n = 89	BB n = 285	WN n = 195	NN n = 245	
Gender, female (%)	420 (51.6)	39 (43.8)	129 (45.3)	95 (48.7)	157 (64.1)	<0.001*
Age (years), mean (SD)	36.6 (10.3)	36.2 (10.3)	35.7 (9.4)	36.8 (11.0)	37.6 (10.7)	0.2514
Nationality, non-Spanish (%)	104 (12.8)	9 (10.1)	46 (16.1)	31 (15.9)	18 (7.3)	0.009*
Occupation, student (%)	106 (13.0)	13 (14.6)	29 (10.2)	37 (19.1)	27 (11.0)	0.027*
Education level, tertiary (%)	501 (61.6)	62 (69.7)	194 (68.1)	92 (47.2)	153 (62.4)	<0.001*
BMI, overweight or obese (%)	219 (26.9)	18 (20.2)	61 (21. 5)	64 (33.0)	76 (31.2)	0.007*
Smoking status, current smoker (%)	224 (27.5)	18 (20.2)	65 (23.0)	65 (33.4)	76 (31.0)	0.018*
Physical activity (MET-min/week),[c] mean (SD)	2639.3 (2577.1)	2960.6 (2471.0)	2896.0 (2274.0)	2505.2 (3043.6)	2331.0 (2513.8)	0.0001*
Children < 18 years, yes (%)	290 (35.7)	31 (34.8)	91 (32.0)	68 (35.0)	100 (40.8)	0.211
Children < 3 years, yes (%)	68 (8.4)	3 (3.4)	25 (8.8)	19 (9.7)	21 (8.6)	0.300
Household income per month, less than 2000€ (%)	255 (41.1)	33 (44.0)	99 (43.8)	56 (40.3)	67 (37.2)	0.552
Neighbourhood deprivation index, high[d] (%)	263 (33.4)	24 (28.6)	88 (31.8)	66 (35.1)	85 (35.6)	0.580
Frequency of utilitarian bicycle trips[e] (days/week), mean (SD)	1.3 (2.0)	2.7 (2.2)	2.3 (2.2)	0.6 (1.3)	0.4 (1.2)	0.0001*
Commuting distance (km), mean (SD)	3.8 (2.1)	3.5 (1.8)	3.2 (1.7)	4.2 (2.1)	4.4 (2.3)	0.0001*
Experience in bicycle commuting (years), mean (SD)	1.9 (3.2)	5.4 (5.7)	3.2 (2.8)	0.8 (2.0)	0.1 (0.6)	0.0001*
Bicycle lane in commuting route, perceiving less than two-thirds (%)	370 (46.2)	33 (37.1)	108 (38.0)	87 (45.3)	142 (60.2)	<0.001*
Private bicycle accessibility, yes (%)	384 (47.2)	89 (100)	111 (38.9)	98 (50.3)	86 (35.1)	<0.001*
Motorcycle accessibility, yes (%)	178 (21.8)	11 (12.4)	26 (9.1)	55 (28.2)	86 (35.1)	<0.001*
Car accessibility, yes (%)	476 (58.5)	54 (60.7)	153 (53.7)	115 (59.0)	154 (62.9)	0.185
Bicing membership, yes (%)	424 (52.1)	29 (32.6)	285 (100)	70 (35.9)	40 (16.3)	<0.001*

Note: Variables with missings: age (n = 1), BMI (n = 3), smoking status (n = 2), children < 18 (n = 2), children < 3 (n = 3), income (n = 194), deprivation index (n = 26), distance (n = 26) and bicycle lane (n = 13).

a:PB: Private Bicycle commuters; BB: Bicing Bicycle commuters; WN: Willing Non-bicycle commuters; NN: Non-willing Non-bicycle commuters.

b:Commuter's differences on the individual and household characteristics were analysed by Chi-square and Kruskal–Wallis tests.

c:Metabolic equivalent of task (MET).

d:A high deprivation index indicates a more disadvantaged socioeconomic status.

e:Utilitarian trips are those with specific destination (i.e. not leisure).

*Statistical significant at P < 0.05 level.

Table 2 Percentages (%) of agreement in general cycling components by type of commuter

		All (N = 814)	Bicycle commuters (n = 374)		Non-bicycle commuters (n = 440)		
Component	**Survey statement[a]**	**N(%)**	**PB (n = 89) n(%)**	**BB (n = 285) n(%)**	**WN (n = 195) n(%)**	**NN (n = 245) n(%)**	**P[b]**
Cycling awareness	Healthy	766 (95.4)	87 (98.9)	273 (97.5)	184 (95.8)	222 (91.4)	0.004*
	Figure-maintaining	754 (92.7)	81 (92.1)	261 (91.6)	186 (95.4)	226 (92.2)	0.432
	Self-confidence	797 (97.9)	88 (98.9)	280 (98.2)	191 (97.5)	238 (97.1)	0.736
	Cheap	757 (93.3)	87 (97.8)	278 (97.9)	183 (93.9)	209 (86.0)	<0.001*
	Eco-friendly	773 (95.2)	88 (98.9)	272 (95.4)	182 (93.8)	231 (94.7)	0.278
	Stress-relieving	682 (85.2)	84 (95.4)	253 (90.0)	168 (88.4)	177 (73.4)	<0.001*
Cycling direct benefits and barriers	Quick	443 (56.0)	74 (83.2)	229 (82.7)	85 (46.0)	55 (22.9)	<0.001*
	Flexible	596 (73.6)	85 (95.5)	247 (86.7)	137 (70.3)	127 (52.7)	<0.001*
	Enjoyable	651 (81.1)	85 (96.6)	276 (97.5)	162 (84.4)	128 (53.3)	<0.001*
	Do not want to ride a bicycle in Barcelona	83 (10.2)	1 (1.1)	9 (3.2)	9 (4.6)	64 (26.1)	<0.001*
	Lack of showers	216 (26.7)	8 (9.0)	34 (11.9)	65 (33.5)	109 (44.5)	<0.001*
	Cargo transportation	307 (37.9)	18 (20.2)	76 (26.8)	84 (43.3)	129 (52.9)	<0.001*
	Personal appearance	212 (26.1)	9 (10.1)	34 (11.9)	57 (29.4)	112 (45.9)	<0.001*
Cycling indirect barriers	Do not want to ride a bicycle in Barcelona[c]						
	Risk of accident	221 (27.3)	6 (6.7)	28 (10.0)	61 (31.3)	126 (51.9)	<0.001*
	Children transportation	337 (45.2)	12 (15.6)	107 (42.5)	97 (53.9)	121 (51.1)	<0.001*
	Inappropriate lanes maintenance	258 (32.6)	22 (24.7)	85 (30.0)	70 (37.0)	81 (35.1)	0.127
	Cargo transportation[c]						
—	Weather[d]	658 (80.9)	59 (66.3)	215 (75.4)	166 (85.6)	218 (89.0)	<0.001*

PB: Private Bicycle commuters; BB: Bicing Bicycle commuters; WN: Willing Non-bicycle commuters; NN: Non-willing Non-bicycle commuters.
a:See Supplementary Tables S1a and S1b in Supplementary Material for a more detailed description of variables and component loadings.
b:Chi-square and Fisher's exact tests to look for significance between survey statements and all commuters' sub-groups.
c:Do not want to ride a bicycle in Barcelona and cargo transportation were loading ($> \pm 0.4$) onto two different components. See percentages of agreement in Cycling direct benefits and barriers component.
d:Weather was the only survey statement that did not load ($< \pm 0.4$) onto any of the seven components obtained.
*Statistical significant at $P < 0.0083$ level (Bonferroni simple correction).

Table 3 Percentages (%) of agreement in public bicycle components by type of commuter

		All (N = 814)	Bicycle commuters (n = 374)		Non-bicycle commuters (n = 440)		
Component	**Survey statement[a]**	**N(%)**	**PB (n = 89), n(%)**	**BB (n = 285), n(%)**	**WN (n = 195), n(%)**	**NN (n = 245), n(%)**	**P[b]**
Public bicycle benefits	Bicycle-maintenance avoidance	767 (94.7)	72 (82.8)	276 (96.8)	189 (96.9)	230 (94.6)	<0.001*
	Parking avoidance	662 (81.7)	58 (65.9)	249 (87.4)	158 (81.0)	197 (81.4)	0.001*
	Low cost	725 (92.1)	73 (83.9)	270 (95.1)	172 (91.0)	210 (92.1)	0.009
	Theft and vandalism	665 (82.3)	39 (43.8)	257 (90.5)	167 (85.6)	202 (84.2)	<0.001*
Public bicycle barriers	No availability of bicycles and docking	508 (65.0)	66 (79.5)	161 (56.5)	127 (67.2)	154 (68.4)	<0.001*
	Poor condition of bicycles	299 (41.0)	41 (50.0)	79 (27.7)	79 (44.9)	100 (52.6)	<0.001*
Suitability of private bicycle parking	Parking in street	164 (20.8)	19 (21.6)	53 (19.7)	44 (23.0)	48 (20.1)	0.830
	Parking at home	203 (25.2)	25 (28.1)	59 (21.1)	49 (25.1)	70 (28.8)	0.203
	Parking at work	280 (34.6)	47 (52.8)	86 (30.6)	78 (40.0)	69 (28.2)	<0.001*
Closeness of public bicycle stations	Stations near home	719 (88.8)	85 (95.5)	269 (94.4)	166 (85.1)	199 (82.6)	<0.001*
	Stations near destinations	694 (86.3)	78 (87.6)	273 (95.8)	161 (83.0)	182 (77.1)	<0.001*

PB: Private Bicycle commuters; BB: Bicing Bicycle commuters; WN: Willing Non-bicycle commuters; NN: Non-willing Non-bicycle commuters.
a:See Supplementary Tables S1a and S1b in Supplementary Material for a more detailed description of variables and component loadings.
b:Chi-square and Fisher's exact tests to look for significance between survey statements and all commuters' sub-groups.
*Statistical significant at $P < 0.0083$ level (Bonferroni simple correction).

difficulty of children transportation, for which BB perceived it as a barrier 27 percentage points more than PB (16% vs. 43% in BB) (table 2).

Public bicycle benefits and barriers

PB, compared with all other commuters, perceived non-availability of bicycles and docking spaces as a greater barrier for using public bicycles (79% vs. 56% in BB $P < 0.001$; 67% in WN $P = 0.002$; 68% in NN $P = 0.003$). Further, avoiding theft and vandalism by using a public bicycle was less motivating for PB compared to all other commuters (43.8% vs. 90.5% in BB; 85.6% in WN; 84.2% in NN; $P < 0.001$) (table 3).

Private bicycle parking suitability and public bicycle station closeness

PB reported to have more safe parking near work/school than all other commuters (53% vs. 31% BB $P < 0.001$; 28% NN $P < 0.001$; 40% WN $P = 0.039$). BB reported to have more stations within walking distance from home (95% vs. 94% PB $P < 0.001$; 85% WN $P < 0.001$; 83% NN $P = 0.001$) and from usual destinations (96% vs. 88% PB $P = 0.006$; 83% WN $P < 0.001$; 77.1% NN $P < 0.001$) (table 3).

Table 4 Effect of attitude and perception of behavioural control components on the type of commuter

	Type of commuter						
	Private Bicycle (PB), n = 89	Bicing Bicycle (BB), n = 285		Willing Non-bicycle (WN), n = 195		Non-willing Non-bicycle (NN), n = 245	
Components	Base sub-group	cRRR (95% CI)	aRRR (95% CI)	cRRR (95% CI)	aRRR (95% CI)	cRRR (95% CI)	aRRR (95% CI)
Cycling direct benefits and barriers	1	0.45 (0.28–0.71)**	0.50 (0.27–0.94)*	0.13 (0.07–0.21)**	0.22 (0.12–0.41)**	0.04 (0.02–0.08)**	0.09 (0.05–0.19)**
Cycling indirect barriers	1	1.60 (1.11–2.29)*	1.86 (1.13–3.08)**	2.68 (1.81–3.96)**	1.75 (1.09–2.82)*	3.61 (2.39–5.46)**	1.92 (1.15–3.19)**
Public bicycle benefits	1	3.44 (2.39–4.94)**	2.35 (1.42–3.90)**	2.71 (1.84–4.01)**	2.51 (1.53–4.14)**	2.25 (1.49–3.40)**	2.15 (1.27–3.66)**

Note. Data imputed (N = 814). cRRR: crude relative risk ratio; aRRR: adjusted relative risk ratio derived from a multinominal logistic regression model. Model adjusted for gender, age, bicycle commuting experience, access to a private bicycle and Bicing membership. Components not shown in the table were not significant at $P < 0.005$ level in the multinominal model.

*Statistical significant at $P < 0.05$ level.

**Statistical significant at $P < 0.001$ level.

Multinomial analysis between attitudinal components and commuter sub-groups

Compared to PB, BB cyclists were 2.0 times [adjusted relative risk ratio (aRRR) = 0.50; confidence interval, CI = 0.27–0.94] less likely to perceive cycling direct benefits and more likely to perceive direct barriers. Similarly, WN were 4.5 times (aRRR = 0.22; CI = 0.12–0.41) and NN were 11.1 times (aRRR = 0.09; CI = 0.05–0.19) less likely to perceive direct benefits and more likely to perceive direct barriers of cycling compared to PB (table 4).

In comparison with PB, the sub-group of BB, WN and NN perceived 1.8 times (aRRR = 1.86; CI = 1.13–3.08), 1.7 times (aRRR= 1.75; CI = 1.09–2.82) and 1.9 times (aRRR= 1.92; CI = 1.15–3.19) more, respectively, cycling indirect barriers (table 4).

BB, WN and NN were 2.3 (aRRR= 2.35; CI = 1.42–3.90), 2.5 (aRRR= 2.51; CI = 1.53–4.14) and 2.1 times (aRRR= 2.15; CI = 1.27–3.66) more likely to perceive advantages toward a public bicycle-sharing system compared to PB.

Discussion

Principal findings

This is the first study to examine differences in attitudes and perceptions of behavioural control between private and public bicycle commuters. It is also unique since it is the first time that attitudes and perceptions of behavioural control toward a European bicycle-sharing system are explored.

This study shows that public-bicycle commuters (BB) perceive less direct benefits and more direct barriers of cycling compared to private-bicycle commuters (PB). This study also indicates that non-bicycle commuters (WN and NN) have stronger positive feelings toward Bicing than private cycling, whereas PB do not find advantages in the use of Bicing.

Perceived direct benefits and barriers of cycling

Attitudes that differentiate each of the four proposed types of commuter are those affecting 'cycling direct benefits and barriers' because they fall into a scale from more (PB) to less positive (NN) attitudes toward these direct benefits and barriers. As private cyclists were hypothesized to be the group with the highest degree of adherence to bicycle commuting, this finding is in accordance with the TPB, which states that, as a general rule, the more favourable the attitude toward a given behaviour, the more likely it will be adopted (19). It is also worth noting that 'cycling direct benefits and barriers' component shares some similarities with the 'direct benefits' proposed by Heinen et al. (22), as both are constructed by 'flexible', quick (or 'time-saving') and enjoyable (or 'pleasant/nice') statements. Her work, conducted in the Netherlands, found that 'direct benefits' attitude influence the mode choice the most, which is supported by our findings.

Given that direct benefits are those that can be experienced directly during the commuting trip, this difference between commuters reinforces the fact that trip-related perceptions have a major impact on individual travel behaviour because they provide an immediate effect if compared to those only noticeable in the long-term such as environmental benefits (23).

Perceived indirect barriers of cycling

Transporting children to and from school has been shown as an additional barrier to cycling for women (15) and a more important barrier than other environmental factors for those willing to cycle (23). Carrying children on bicycles in this study was found to be a major indirect perceived barrier for public cyclists than private cyclists. This could be because public cyclists have more safety concerns when carrying their children on a bicycle, and therefore they do not own a private bicycle. However, as 20% of trips in rush hours in European inner cities are undertaken to transport children to school in cars (40), one way to overcome this perceived barrier is providing access to child seat carriers in some public bicycles or developing promotional campaigns (e.g. discounts for these accessories among members). This would aim to encourage public bicycle users with children to increase their use frequency as well as to encourage willing non-bicycle commuters with children to start bicycle commuting.

Motivators of bicing use

Convenience has arisen as an important motivator for using shared bicycles in different cities worldwide (11,28,29). In this study, Bicing commuters found the avoidance of bicycle maintenance, the low cost of the system and not having to worry about theft and vandalism as the most important facilitators to commute by Bicing. This finding supports prior results from Canada (29), where the authors concluded that wanting to avoid bicycle maintenance increased the frequency of use of public bicycles and that public bicycle participation was closely related to previous bicycle theft experience (29). In this sense, our private cyclists were the group that perceived less worries about bicycle theft and vandalism when using their own bicycles. Although it is unknown if these subjects had had a bicycle stolen, and it is unclear whether feeling safer precedes choosing a private bicycle or vice versa, this finding exemplifies the attitudinal gap between PB and BB and also lends weight to the importance of bicycle-sharing systems as a gateway to risk-averse individuals who may not otherwise use bicycles.

Barriers of bicing use

Although there were no significant differences in negative attitudes toward Bicing across commuters, private cyclists felt that the uncertainty of finding available bicycles and parking is an obstacle to use public bicycles. As Bicing imposes a financial penalty if the trip lasts more than half an hour, not finding parking could lead to more travel time than expected and thereby to a financial penalty. This limited flexibility explains why private cyclists, who can travel door-to-door, perceive this as a great impediment of Bicing commuting.

Bicing commuters were most likely to perceive having a Bicing station within walking distance from home as important. This is in accordance with previous similar research which found that living within 250 m (30) and even 500 m from a docking station (29) increases the likelihood of using public bicycles. Although this perception should be confirmed with objective methods, it suggests that station coverage and location is essential to influence commuter's willingness to use shared bicycles (30).

Strengths and limitations

The prioritization of bicycle commuters' recruitment was an intentional and necessary component in the study design to ensure that they were adequately represented in the final sample. Although this led to an over-representation of the number of cyclists in the study, it would not affect the estimation of the relationship between attitudes and perceptions and travel behaviour. Because of this non-random nature of the overall sample, the data should not be interpreted as representative of the general commuting population of Barcelona. However, a representative distribution of age, gender, education, neighbourhood deprivation index, population density and destination density was found in agreement with Barcelona's active population (data not shown). Another point in this quantitative research was the control for a wide range of personal and household determinants of bicycle commuting, which could not have happened with a qualitative approach. It is also worth noting that the loss of precision and power due to some missing responses was compensated with the application of multiple imputation technique (and many rounds of it), which helped to deal with uncertainty from missing data.

Other limitations of our study are that subjective norm and attitudes toward other modes, which may also influence bicycle commuting decisions (17,19), were not evaluated. Another limitation of the study concerns the classification of commuters by their one-way trip to work/school, which could have reduced the differences in attitudes and perceptions between Bicing (BB) and non-Bicing sub-groups because those subjects classified as non-bicycle commuters (WN and NN) may have returned home by public bicycle.

Given the country-specific essence of attitudes and perceived behavioural control, results may not be generalized to all countries, although our findings may help cities with a bicycle-sharing initiative to distinguish the attitudinal profile of proposed commuter sub-groups.

Conclusion

Public cyclists perceived cycling as less quick, flexible and enjoyable mode compared to private cyclists. Willing non-bicycle and public-bicycle commuters had a favourable perception toward public-shared bicycles, feeling that the most important facilitators are the avoidance of bicycle maintenance and theft and vandalism and the low cost of the system. This highlights the role that public-shared bicycles play in active commuting: addressing barriers that private bicycles do not. Hence, public bicycles may be the impetus for those willing to start bicycle commuting, thereby increasing physical activity levels and thus reduce automobile dependence and increase healthy lifestyles.

Supplementary data

Supplementary data are available at *EURPUB* online.

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Key points

- Attitude and perception of behavioural control can be greater determining factors to bicycle commuting compared to environmental variables.
- This is the first study to explore differences between private and public bicycle commuters, showing that public cyclists perceive less direct benefits.
- The most important facilitators of public bicycles were the avoidance of bicycle maintenance and theft and vandalism, and the low cost of the system, whereas the absence of child seat carriers may be a main barrier.
- Public bicycle-sharing initiatives may be a gateway for those willing to shift to bicycle commuting, thereby increasing physical activity levels.
- Findings are important to adapt cities to cycling and thus reduce automobile dependence and increase healthy lifestyles.

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