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journal homepage: www.elsevier.com/puhe

Original Research

Physical activity by stealth? The potential health benefits of a workplace transport plan

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ARTICLE INFO

Article history:
Received 20 May 2010
Received in revised form
7 December 2010
Accepted 7 January 2011
Available online 31 March 2011

Keywords:
Physical activity
Active commuting
Transport plan

SUMMARY

Objectives: There are few published evaluations of the effects of travel policy on health-enhancing physical activity. The purpose of this study was to investigate the effect of a workplace travel plan, which mainly focused on restricting parking opportunities, on levels of active commuting and its potential to contribute to public health.
Study design: Analysis of a repeated bi-annual travel survey in a workplace setting.
Methods: Usual mode of commuting, gender, age, worksite location and distance commuted to and from work were obtained from the University of Bristol Staff Travel Surveys conducted in 1998 ($n = 2292$), 2001 ($n = 2332$), 2003 ($n = 1950$), 2005 ($n = 2647$) and 2007 ($n = 2829$). Z-tests were used to examine the significance of trends in active commuting between 1998 and 2007. The largest and most recent survey (2007) was used to calculate the effects of gender, age and salary band on mode of transport, length of commuter journey, and the extent to which active commuting contributed to meeting national recommendations for physical activity.
Results: Results showed that between 1998 and 2007, in contrast to national trends, the percentage of respondents who reported that they usually walked to work increased from 19.0% to 30.0% ($Z = 4.24$, $P < 0.001$). The percentage of regular cyclists increased from 7.0% to 11.8%, but this was not statistically significant. In 2007, regular walkers were more likely to be female, under 35 years of age and earning a middle-band salary. Regular cyclists were more likely to be male, aged 36–45 years and earning a higher-band salary. Approximately 70% of respondents who usually walked or cycled to work achieved greater than 80% of the recommended guidelines for physical activity through their active commuting.
Conclusions: This study suggests that transport plans aimed at reducing car usage should be considered as a feasible and effective strategy for increasing health-enhancing physical activity among the workforce.

Introduction

Promoting participation in regular, moderate-intensity physical activity is a public health priority in the UK[1] and Europe.[2] Physical activity reduces the risk of morbidity and mortality from cardiovascular disease, diabetes and some cancers, and assists in the maintenance of a healthy weight.[3,4] Additionally, regular physical activity can reduce the risk of depression and dementia, and has positive benefits for mental well-being.[4] Government guidelines state that adults need to accumulate

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0033-3506/$ – see front matter
doi:10.1016/j.puhe.2011.01.005

at least 30 min of moderate-intensity physical activity on at least 5 days/week, representing a total of 150 min/week.[3] Daily amounts can be achieved with similar positive effects through either a single 30-min session or several shorter bouts of activity of 10 min or more. However, a large proportion of the UK population does not meet these recommendations. The 2008 Health Survey of England[5] indicated through self-report that only 39% of adult men and 29% of women met weekly recommended levels of physical activity. Clearly, feasible and effective strategies for increasing levels of activity are required if public health benefits are to be realised.

Health policy makers are engaged in several options aimed at motivating people to become more active. These include support through general practitioner referral for exercise schemes, a new physical activity care pathway ('Let's Get Moving') and by increasing access to leisure opportunities such as free swimming, many of which are already part of English national policy.[1,6] However, there is concern that such schemes are more successful in attracting health-conscious, better-educated sectors, and overall these may increase health inequalities. A challenge remains to find acceptable modes of activity that can be incorporated into people's everyday lives,[7] and that also appeal to people from health-needy backgrounds. An alternative to physical activity as leisure, where barriers such as lack of motivation, cost and time constraints are often reported, is to promote naturally occurring activity such as walking and cycling as modes of daily travel.[8]

The World Health Organisation Charter on Transport, Environment and Health[8] reported that the average walking journey in Europe is approximately 1.5 km, and the average cycling trip is 3.5 km, each taking approximately 15 min. However, national levels of daily walking have decreased steadily as car usage has increased.[9] Walking and cycling to and from work may therefore have the potential to increase health-enhancing physical activity, especially if reduced usage of the car can be incentivised.[10] At the same time, reductions in car usage would help cut emissions, reduce congestion and stimulate improvements in public transport provision.[9] Therefore, an alternative approach to increasing opportunities for activity is to make car use more difficult.

Such an opportunity has arisen at the University of Bristol where, in 1999, a transport plan (www.bristol.ac.uk/transportplan/plan/theplan.html) was launched to ease congestion and onsite parking problems, and release parking spaces for building. Improved health or increased physical activity were not objectives of the Bristol University Transport Plan. The purpose of this study is therefore to assess the collateral impact of a transport plan that focused on reduced car usage on employee levels of walking and cycling to work. Transport plans have rarely been evaluated in terms of their health impact.[11] A particular objective, therefore, was to attempt to estimate the potential of active travel to contribute to recommended amounts of activity for health.

Methods

Setting and strategy

The main precinct of the University of Bristol is located on an elevated site within 1 mile of the city centre, so space for building development is very limited and land prices are at a premium. Strategies of its Transport Plan featured both 'carrot' and 'stick' measures, including heavily limiting parking spaces and conditions for permits, increased parking charges, improving changing facilities for walkers and cyclists, new secure cycle storage, a subsidised cycle purchase scheme, a car-sharing scheme, a free university bus service which served local train and bus stations, and discounted season tickets on buses. Changes to the parking and permit conditions and charges were implemented in August 2000, 12 months after the plan's publication, in order to allow employees sufficient time to explore alternative methods of travelling to work. In 2001, Bristol City Council also reduced the availability of non-resident parking in areas surrounding the University. From the outset, improving health or increasing physical activity were not objectives of the plan, and were only mentioned tangentially in documentation.

The University of Bristol Staff Travel Survey

The survey is a self-administered questionnaire. It was posted to every member of staff in November 1998 and 2001, and was e-mailed for completion online in November 2003, 2005 and 2007. The 1998 survey data provided a pre-campaign assessment, and were compared with a University of Bristol travel survey carried out in 1993 and a Bristol City Council survey undertaken in 1997. This comparison indicated a similar split in employees' usual mode of transport to work across all three surveys.[12] The survey assesses employees' location of work in the university, their residential postcode, commuting habits, car parking arrangements and motives for reducing car usage. The 2005 version added gender and salary questions, and the 2007 version also added age.

The study sample was employees completing the Bristol Travel Survey. Sample sizes (with % response) were as follows: 1998, $n = 2292$ (54.4%); 2001, $n = 2332$ (45.4%); 2003, $n = 1950$ (37.5%); 2005, $n = 2647$ (49.9%); and 2007, $n = 2829$ (49.2%). The number of respondents who completed the survey for more than 1 year is not known as it is not possible to match responses.

Study variables

The main survey variable selected for trend analysis was employees' usual mode of transport to work. In order to characterise active commuters, the 2007 data were used to determine associations between demographic factors and mode of travel to work, and the contribution of active travel to government-recommended levels for health. Table 1 provides a comparison between the key demographic characteristics of the 2007 sample with those of the full staff population of the University of Bristol in 2007.

Mode of transport

Each survey included the question 'How do you travel to work?', categorised into 'usually' (four to five times per week), 'sometimes' (two to three times per week) and 'occasionally' (once or less per week). For this paper, responses were grouped into 'walk', 'cycle', 'car user' and 'other' categories. 'Car user' represented pooled data for car driver (on own), car driver (at least one passenger), car passenger and car sharer (formally

Table 1 – Demographics of staff responding to the 2007 Travel Survey, compared with the total staff population of the University of Bristol.

	2007 survey respondents *n* (%)	Total staff population of the University of Bristol *n* (%)
Gender		
Male	1224 (43.3)	2708 (47.1)
Female	1605 (56.7)	3046 (52.9)
Age (years)		
<25	144 (5.1)	278 (4.8)
26–45	1692 (59.8)	3154 (54.8)
46–55	600 (21.2)	1307 (22.7)
>56	393 (13.9)	1015 (17.7)
Salary band		
<15 K	331 (11.7)	1175 (20.4)
15–20 K	340 (12.0)	709 (12.3)
20–25 K	410 (14.5)	678 (11.8)
25–30 K	418 (14.8)	666 (11.5)
30–40 K	677 (23.9)	1217 (21.2)
40–50 K	385 (13.6)	811 (14.1)
>50 K	268 (9.5)	498 (8.7)

matched through a car-sharing scheme). The 'other' category included bus, train, hospital and university bus shuttle, park and ride, and motorbike/moped/scooter as modes of transport.

Length of commuter journey

Data regarding the length of the commuter journey to and from work were extracted from the 2007 survey. A survey question stated: 'How long did your door-to-door journey to work take today?' Respondents chose from: 'up to 15 min'; '16–30 min'; '31–45 min'; '46–60 min'; 'over 1 h and up to 1 h 15 min'; over 1 h 15 min and up to 1 h 30 min' or 'more than 1 h 30 min'. Similarly, a survey question stated: 'How long did your door-to-door return journey home take today?' with identical categories for responses.

Data analyses

Raw data were unavailable for the 1998 and 2001 surveys, so summary data were obtained from the University of Bristol Transport Plan web pages (http://www.bristol.ac.uk/transportplan/surveys/01survey.html). Raw data from the 2003, 2005 and 2007 surveys were obtained from the Bristol Online Surveys website, which contained individual survey responses together with summary data for each survey question in each year (http://www.survey.bris.ac.uk/).

Trend analyses

Using data from the 2002, 2003, 2005, and 2007 surveys, the percentage of survey respondents who reported walking and cycling as their usual mode of commuting were calculated. Differences in proportions of respondents reporting walking, cycling, car or other mode of travel between each year and the final year (2007) were assessed for significance using two-tailed Z-tests based on the following algorithm:

$$\frac{\widehat{p}_1 - \widehat{p}_2}{\sqrt{\mathrm{var}(\widehat{p}_1) + \mathrm{var}(\widehat{p}_2)}}$$

where $\mathrm{var}(\widehat{p}_1)$ is the estimated variance of $\widehat{p}_1$ and $\mathrm{var}(\widehat{p}_2)$ is the estimated variance of $\widehat{p}_2$. The variance of $\widehat{p}_1$ or $\widehat{p}_2$ is estimated by $\widehat{p}_i(1-\widehat{p}_i)/n_i$ where n_i is the sample size (total number of respondents in year of survey).

Characteristics of active and non-active commuters

Using the 2007 survey, data regarding respondents' usual mode of transport (walkers, cyclists, car users and other) were cross-tabulated. Chi-squared tests were used to assess group differences for gender, age and salary band using weighted cases.

Contribution of active commuting to meeting physical activity recommendations

Data were extracted from the 2007 survey for length (in min) of commuter journeys (each way) for usual, sometimes and occasional walkers and cyclists in the 2007 survey. Respondents who failed to answer the questions relating to the length of their outward or return commuter journey were excluded from analyses. Outward and return commuter journeys were added together to create daily time spent in active commuting: 'up to 30 min'; '31–60 min'; '61–90 min'; '91–120 min'; and '>120 min'. Frequency of days of active travel per week was estimated conservatively as 4, 2 and 1 for usual, sometimes and occasional walkers or cyclists, respectively. Time and frequency were multiplied and then divided by 150 (total number of recommended minutes of physical activity per week) to produce the percentage of recommended time met by active commuting.

Results

Trends in active commuting

Fig. 1 shows that between 1998 and 2007, the percentage of respondents who reported that they usually (four to five times per week) walk to work increased from 19% to 30%. A two-tailed Z-test showed a statistically significant difference between the 2007 figures ($P < 0.01$) and each year with the exception of 2005. The percentage of respondents who reported that they usually cycle to work increased from 7% to 12%, but year comparisons with 2007 data failed to reach significance. Over the same period, the percentage of respondents who usually commuted by car decreased from 50% to 33% ($P < 0.001$). The percentage of respondents who reported that they usually commuted by other motorised modes of transport showed an overall non-significant increase from 24% to 25%. These changes appear to have been gradual. During the first 2 years (to 2001), the 8% decrease in regular car use was accompanied by a 3% increase in commuting by other forms of motorised transport such as buses. Levels of walking and cycling were higher for each subsequent survey over a period of 9 years.

Factors associated with usual mode of travel

Gender

Fig. 2 shows the mode of travel by gender for the 2007 survey, showing a significantly different distribution for males and

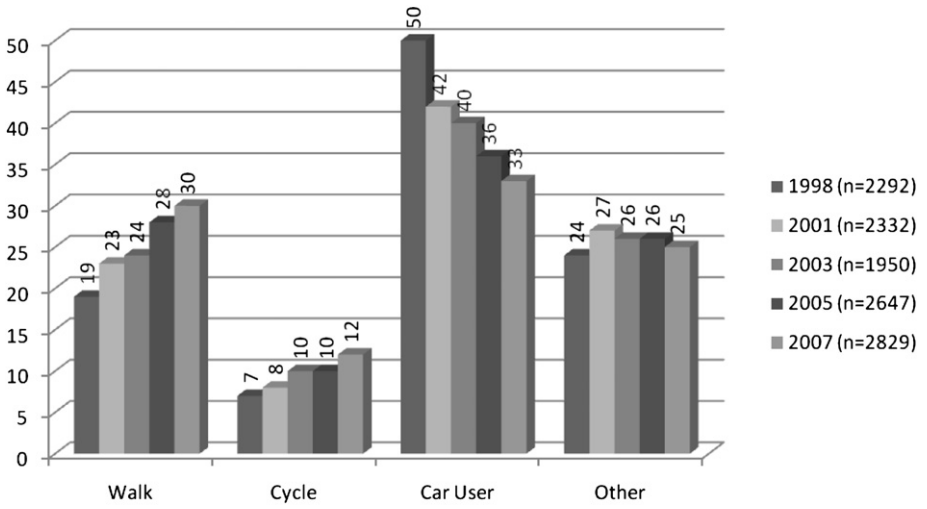

Fig. 1 – Percentage of respondents commuting on foot, by bicycle, by car (driver or passenger) or by any other mode of transport by year of survey.

females (χ^2=82.58, df=3, $P\leq0.001$). A greater proportion of females usually commuted on foot compared with males (6% difference). However, for cycling, a greater proportion of males usually cycled compared with females (7% difference). In addition, a greater proportion of female respondents usually commuted by car (10% difference), and 9% more males usually used some other form of motorised transport compared with females.

Age

Chi-squared analyses also indicated significant differences in mode of travel by age ($\chi^2 = 164.609$, $df = 12$, $P \leq 0.001$). Active forms of travel overall were highest in the 16–35 year age groups, at 57% for 16–25 year olds and 61% for 26–35 year olds. Fig. 3 shows that for the 2007 survey, the highest proportion of walkers were aged 26–35 years (47%). However, the greatest proportions of cyclists were aged 36–45 years (19%). Lowest prevalence in active commuting (28%) was found in those aged >56 years, who were also more likely to use cars for travel to work (46%).

Salary

Chi-squared analysis showed that there was a significant difference between usual modes of travel by income band ($\chi^2 = 99.727$, $df = 18$, $P\leq0.001$). The highest proportion of walkers were those whose salary was £25–30 K/year (38%), and the greatest proportion of cyclists earned >£50 K (16%). The highest proportion of car users earned £20–25 K/year. Respondents who earned <£15 K/year were the most infrequent walkers and cyclists (24% and 6%, respectively), but the greatest users of other modes of transport (45%) (Fig. 4).

Active commuting and health recommendations for physical activity

Based on estimates of how different commuter journey times correspond with different proportions of the recommendations of physical activity for usual active commuters (Appendix 1), approximately 67% of usual walkers ($n = 849$) and approximately 63% of usual cyclists ($n = 333$) were meeting >80% of their weekly physical activity requirement in terms of time commitment (Fig. 5).

Even those who classed themselves as 'sometimes' active commuters (two or three times per week) were contributing significantly to their weekly requirements, with approximately 73% of walkers and 75% of cyclists meeting >40% of their physical activity requirement.

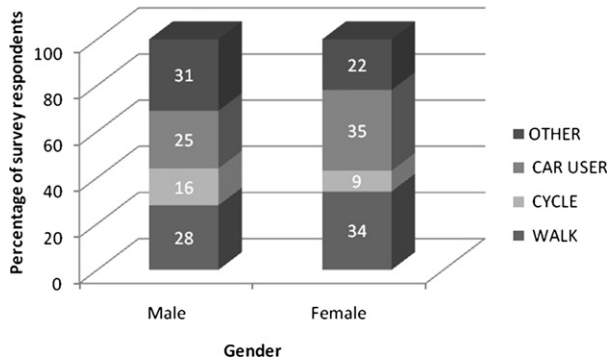

Fig. 2 – Usual mode of transport by gender.

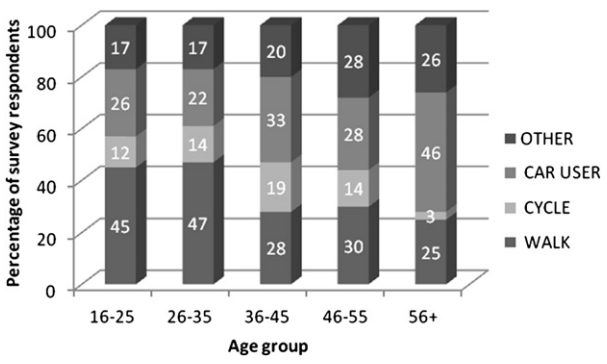

Fig. 3 – Usual mode of transport by age group.

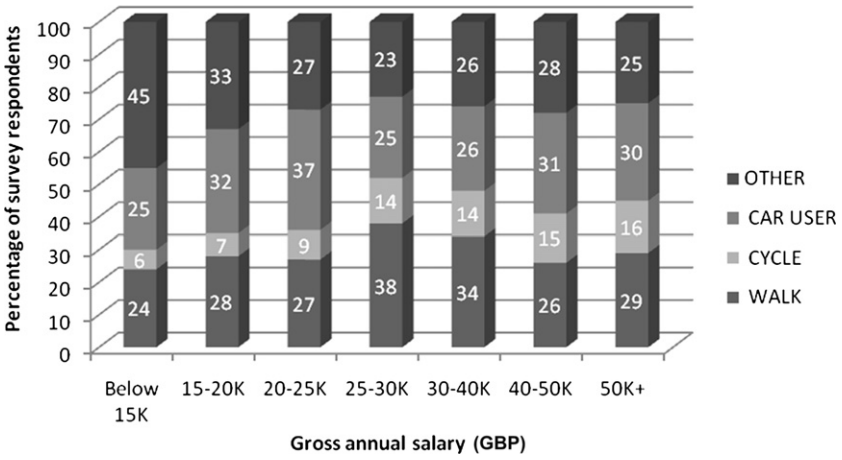

Fig. 4 – Usual mode of transport by salary band.

Discussion

Main findings

The University of Bristol Transport Plan was initiated to reduce congestion and parking. Increasing physical activity or improved health was not an objective of the policy. A baseline and four follow-up surveys have allowed an estimate of the effects of the scheme on active commuting.

During the time the scheme has been operating, there has been a year-on-year increase in percentages of respondents who report walking as their primary mode of travel to work. Increases in percentages of respondents who report cycling as their primary mode of travel to work did not reach statistical significance, due to the low number of respondents in this category. This was accompanied by a large reduction in car usage. Strategies were in place by 2000, so this would suggest that several years are required to realise the full effect on active travel; an issue previously raised elsewhere.[7]

In 2007, mode of travel to work was associated with gender, age and salary band. Walkers were more likely to be female, under 35 years of age and in middle salary bands. However, respondents who regularly used a car to commute were also more likely to be female. Conversely, cyclists were twice as likely to be male, aged 36–45 years and in higher salary bands (£25–40 K/year). A higher proportion of males also used other forms of transport (30.7% vs 21.6%). To some extent, these patterns may reflect differing distributions of residential location for female and male workers. However, they also support the conclusion that walking to work may be a viable strategy for increasing activity in women, whereas there may be additional barriers to cycling for women.[13]

In the 2007 survey, 42% of respondents usually walked or cycled to work (at least four times per week). The conservative estimates of time taken suggest that approximately 70% of these commuters were meeting at least 80% of the weekly recommended guidelines of 150 min of physical activity. In addition, approximately 70% of 'sometimes' walkers and cyclists (two to three times per week) were estimated to be meeting

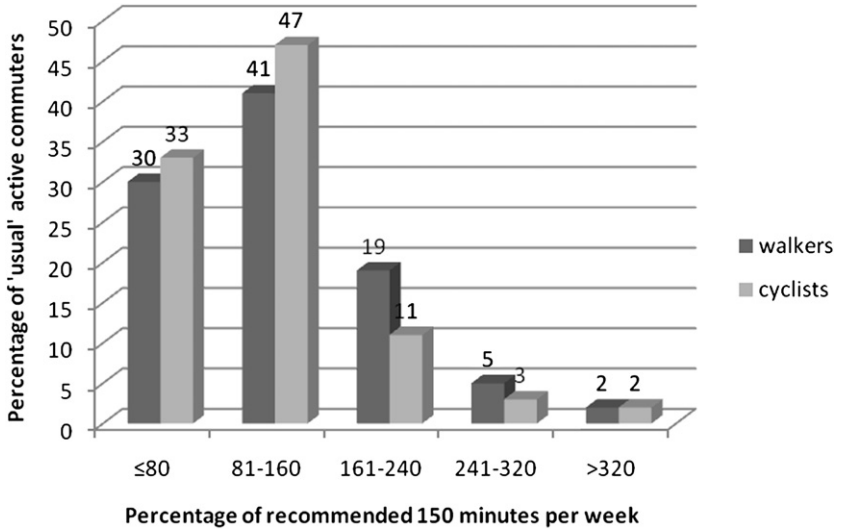

Fig. 5 – Percentage of usual active commuters meeting different percentages of the recommended amount of weekly physical activity (150 min/week).

>40% of their physical activity requirement. Assuming that travel was continuous, active commuters are also sustaining activity for longer than the required 10-min bouts.

Active commuting is seen as an important strategy to increase population levels of health-related physical activity.[1] A recent study showed that active commuters are fitter, less likely to be overweight or obese, have lower blood pressure, and lower triglyceride and insulin levels.[14] The small number of interventions aimed at persuading individuals to increase active travel to work have provided some success.[15] However, in the UK, there was a 10% reduction in the number of commuting trips per week, and a 25% reduction in trips taken as walking and cycling from 1997 to 2007. The car continued to be the main mode of transport for commutes to work (69%), with 8% and 3% walking and cycling, respectively.[16]

The data from this study indicate that the commuting habits of staff at the University of Bristol show opposite trends to national surveys. Over a period of 8 years, an increasing percentage of commuters have taken active options with a significant reduction in car usage. Furthermore, active travellers met a substantial proportion of the recommendations for physical activity[17] through their commuting. For approximately 70% of respondents who usually walk or cycle to work, only a further 30 min of moderate-intensity physical activity is needed at weekends to meet recommendations for health. Change appears to have been stimulated by the introduction of a range of costs, such as limited and more expensive parking, accompanied by increasing the attractiveness of alternative modes of transport to the car. Although this travel plan was not conceived as health promotion, the data indicate that it may have achieved a level of change in physical activity that has rarely been reported in purpose-designed physical activity interventions.[18]

This study has its limitations. These analyses take the form of a series of cross-sectional survey comparisons, so change within individuals cannot be established. The survey response rate was just less than 50%, but the respondent profile was reflective of the total workforce in terms of gender, age and salary band. It is possible that responses are biased to represent more health-conscious active commuters.

The absence of a control or comparison group means that it is not possible to be sure that implementation of the Transport Plan caused the change in commuting patterns. However, these findings are against national trends in active commuting.[16] Furthermore, the authors have been unable to find any other substantive local infrastructure change or campaign within the survey period that was sufficiently powerful and relevant to travel to the University that may provide an alternative explanation for the results.

The authors were unable to identify the effects of individual strategies of the plan, so the relative effects of the 'stick' measures (mainly parking restrictions) and 'carrot' measures (such as improved public transport and facilities for walkers and cyclists) cannot be determined. Furthermore, there is no indication of degree of intensity of the activity, so it cannot be ascertained that active commuters were reaching the level of moderate intensity which provides greatest health benefit. However, commuters tend to walk briskly, and most routes to the University of Bristol involve uphill walking which will increase the intensity of physical activity. Finally, an impact of active travel on total activity cannot be implied for any individual. The authors simply contend that the findings support the view that active travel is an effective means of getting activity into weekly routines.

Conclusions

This study shows that a workplace transport plan aimed at decreasing car usage through restricted parking can significantly increase active travel through walking and cycling. The amounts of walking or cycling achieved among the active travellers were sufficient to meet a large percentage of the weekly recommended amounts for health benefits. Workplace transport plans should be considered a feasible and effective physical activity promotion strategy that can have public health impact.

Ethical approval

University of Bristol Exercise and Health Sciences Ethics Committee (Application No.: 012/06).

Funding source

None declared.

Conflict of interest

None declared.

Acknowledgements

The authors would like to thank Amy Watts and Martin Wiles, University of Bristol, for their assistance in accessing and interpreting the Bristol University Staff Travel Surveys. They would also like to thank Po Wen Ku, Taiwan Ministry of Sport, for his statistical help.

REFERENCES

1. Department of Health. *Be active be healthy: a plan for getting the nation moving*. London: Department of Health; 2009.
2. World Health Organization. *Physical activity and health in Europe: evidence for action*. Denmark: World Health Organization Europe; 2006.
3. Department of Health. *At least five a week: evidence of the impact of physical activity and its relationship to health: a report from the Chief Medical Officer*. London: Department of Health, Physical Activity, Health Improvement and Prevention; 2004 [p. i–vi].
4. US Department of Health and Human Services. *Physical activity guidelines for Americans*. Washington, DC: US Department of Health and Human Services; 2008.
5. Craig R, Mindell J, Hirani V. *2008 Health survey for England*. Leeds: The Health and Social Care Information Centre; 2009.

6. Scottish Executive. *Let's make Scotland more active: a strategy for physical activity*. Edinburgh: The Stationery Office; 2003.
7. Lawlor DA, Ness AR, Cope AM, Davis A, Insall P, Riddoch C. The challenges of evaluating environmental interventions to increase population levels of physical activity: the case of the UK National Cycle Network. *J Epidemiol Community Health* 2003; **57**:96–101.
8. WHO Regional Office for Europe. *Physical activity: charter on Transport, environment and health*. London: World Health Organization; 1999. p. 17–8.
9. Department for Transport. *The future of transport: a network for 2030*. London: The Stationery Office; 2004.
10. Oja P, Vuori I, Paronen O. Daily walking and cycling to work: their utility as health-enhancing physical activity. *Patient Educ Counsel* 1998;**33**:S87–94.
11. Insall P. Can we achieve evidence-based policy and practice on active travel? *J Public Health Policy* 2009;**30**:S21–5.
12. University of Bristol. *Travel to work group report (5 March 1999): final recommendations*. Bristol: University of Bristol; 1999.
13. Mutrie N, Carney C, Blamey A, Crawford F, Aitchison T, Whitelaw A. Walk in to work out: a randomised controlled trial of a self help intervention to promote active commuting. *J Epidemiol Community Health* 2002;**56**:407–12.
14. Gordon-Larsen P, Boone-Heinonen J, Sidney S, Sternfield B, Jacobs DR, Lewis CE. Active commuting and cardiovascular disease: the CARDIA Study. *Ann Intern Med* 2009;**169**:1216–23.
15. Ogilvie D, Egan M, Hamilton V, Petticrew M. Promoting walking and cycling as an alternative to using cars: systematic review. *BMJ* 2004;**329**:763–6.
16. Department for Transport. *Travel to work: personal travel factsheet – july 2007*. Department for Transport; 2007.
17. Vuori IM, Oja P, Paronen O. Physically active commuting to work – testing its potential for exercise promotion. *Med Sci Sports Exerc* 1994;**26**:844–50.
18. Hillsdon M, Foster C, Cavill N, Crombie H, Naidoo B. *The effectiveness of public health interventions for increasing physical activity among adults: a review of reviews*. London: Health Development Agency; 2005.

Appendix 1. Estimates of how journey lengths correspond to proportions of the recommended guidelines for physical activity.

Usual active commuters (four to five times per week)

Length of daily commuter journey (min)	Proportion of the recommended guidelines for physical activity (%)
≤30	≤80
31–60	81–160
61–90	161–240
91–120	241–320
>120	>320

Sometimes active commuters (two to three times per week)

Length of daily commuter journey (min)	Proportion of the recommended guidelines for physical activity (%)
≤30	≤40
31–60	41–80
61–90	81–120
91–120	121–160
>120	>160

Occasional active commuters (once or less per week)

Length of daily commuter journey (min)	Proportion of the recommended guidelines for physical activity (%)
≤30	≤20
31–60	21–40
61–90	41–60
91–120	61–80
>120	>80