



Foster, C., Adams, E., & Bull, F. (2016). Are perceptions of the environment in the workplace 'neighbourhood' associated with commuter walking? *Journal of Transport and Health*, 3(4), 479-484.  
<https://doi.org/10.1016/j.jth.2016.01.001>

Publisher's PDF, also known as Version of record

License (if available):  
CC BY

Link to published version (if available):  
[10.1016/j.jth.2016.01.001](https://doi.org/10.1016/j.jth.2016.01.001)

[Link to publication record in Explore Bristol Research](#)  
PDF-document

This is the final published version of the article (version of record). It first appeared online via Elsevier at <https://doi.org/10.1016/j.jth.2016.01.001> . Please refer to any applicable terms of use of the publisher.

## University of Bristol - Explore Bristol Research

### General rights

This document is made available in accordance with publisher policies. Please cite only the published version using the reference above. Full terms of use are available:  
<http://www.bristol.ac.uk/pure/about/ebr-terms>



# Are perceptions of the environment in the workplace ‘neighbourhood’ associated with commuter walking?



Emma J. Adams<sup>a,\*</sup>, Fiona C. Bull<sup>b</sup>, Charlie E. Foster<sup>c</sup>

<sup>a</sup> British Heart Foundation National Centre for Physical Activity and Health, School of Sport, Exercise and Health Sciences, Loughborough University, Loughborough LE11 3TU, UK

<sup>b</sup> School of Sport Science, Exercise and Health, The University of Western Australia, Perth, Australia

<sup>c</sup> British Heart Foundation Centre on Population Approaches for Non-Communicable Disease Prevention, Nuffield Department of Population Health, University of Oxford, Old Road, Headington, Oxford OX3 7LF, UK

## ARTICLE INFO

Available online 29 January 2016

### Keywords:

Walking  
Transport  
Commuting  
Workplace  
Environment  
Physical activity

## ABSTRACT

Walking for the daily commute is one potential strategy for increasing physical activity levels. Understanding the behaviour-specific environmental correlates associated with commuter walking will help effective interventions to be identified and developed. The aim of this study was to examine the associations of perceptions of the environment in the workplace ‘neighbourhood’ and commuter walking.

Participants in the baseline survey of the Walking Works intervention study reported perceptions of ten environmental attributes in their workplace neighbourhood, availability of public transport, time spent walking to and from work in the last seven days, their participation in physical activity and socio-demographic characteristics ( $n=676$ ). We built a series of multivariate logistic regression models to examine associations between each environmental item, public transport availability and commuter walking.

Half (52%) of respondents were classified as commuter walkers ( $n=352$ ) (66% female; 47% aged < 30 years). Respondents were significantly more likely to walk for their daily commute if they reported there to be convenient walking routes (OR (odds ratio) 2.05, 95% CI (confidence interval) 1.23–3.42), suitable pavements (OR 2.23, 95% CI 1.23–4.04), maintained pavements (OR 1.64, 95% CI 1.02–2.62) or convenient public transport (OR 4.98, 95% CI 3.34–7.44) after adjusting for socio-demographic characteristics, free car parking at work and distance lived from work.

Creating ‘pedestrian friendly’ environments in workplace surroundings may be important for encouraging walking for the daily commute to work. Such environments would include convenient routes, suitable and maintained pedestrian infrastructure and convenient access to public transport. Improving and maintaining the walking environment around existing workplaces and ensuring infrastructure around new workplaces is designed to support commuter walking should be considered a priority area for investment.

© 2016 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

## 1. Introduction

Participating in regular physical activity and regular walking is known to benefit health (Department of Health, 2011; Kelly et al., 2014). However, 33% of males and 45% of females in England do not meet current physical activity recommendations (Department of Health, 2011; Craig and Mindell, 2013). Strategies are urgently needed to increase participation at the recommended levels to reduce the public health and economic burden of diseases associated with low levels of physical activity (Allender et al., 2007; Scarborough et al., 2011). It is estimated that only between 9% and 11% of adults in England walk for the commute to work (Department for Transport, 2013; Office for National Statistics, 2011) with a high proportion (69%) choosing to drive (Department for Transport, 2013). Increasing the number of individuals who walk for all or part of their daily commute to and from work is one potential strategy to increase overall physical activity levels and improve health (Department of Health, 2011), as well as to reduce carbon emissions and traffic congestion (Department for

\* Corresponding author. Tel.: +44 1509 226422.

E-mail addresses: [e.j.adams@lboro.ac.uk](mailto:e.j.adams@lboro.ac.uk) (E.J. Adams), [fiona.bull@uwa.edu.au](mailto:fiona.bull@uwa.edu.au) (F.C. Bull), [charlie.foster@dph.ox.ac.uk](mailto:charlie.foster@dph.ox.ac.uk) (C.E. Foster).

Transport, 2011). In addition, evidence suggests that accumulating bouts of at least 10 minutes of moderate intensity activity may be sufficient to provide health benefits (Department of Health, 2011). The journey to and from work provides two opportunities to accumulate short bouts of activity such as this on each day an individual travels to work, either through walking alone, or walking in combination with the use of public or other motorised transport.

Ecological models identify the physical environment as an important influence on physical activity behaviour (Sallis et al., 1998). Much research has focussed on walking and associations with perceptions of environmental attributes in the residential neighbourhood (Adams et al., 2013; Owen et al., 2004; Saelens et al., 2003; Saelens and Handy, 2008; Van Dyck et al., 2012; Van Holle et al., 2012), which is typically defined as 'within 10–15 minutes' walk from home'. Few studies have assessed perceptions of the walking environment at trip destinations, such as the workplace, which might fall outside of this 10–15 min walk boundary. The importance of studying specific behaviours within clearly defined environments and the need to identify behaviour-specific environmental correlates has been highlighted previously (Giles-Corti et al., 2005).

It is important to identify and develop appropriate strategies to promote and support commuter walking based upon a better understanding of behaviour-specific environmental correlates of the behaviour. Commuter walking is defined as walking for the entire journey to or from work, or walking for part of the journey to work in combination with other modes of transport including by car and by public transport such as bus or train. It could be hypothesised that perceptions of the walking environment in the workplace 'neighbourhood' might influence commuter walking. Only two studies have previously assessed perceptions of environmental attributes in the workplace neighbourhood with walking or physical activity, however neither specifically reported associations with commuter walking as a discrete behaviour and both were conducted outside of the UK (Adlakha et al., 2015; Schwartz et al., 2009). The aim of this study was to examine the association of perceptions of the environment in the workplace 'neighbourhood' and commuter walking in adults employed in England.

## 2. Methods

### 2.1. Data collection and sample

The 'Walking Works' intervention project aimed to engage with five employers in England and develop walk to work schemes through recruiting volunteer 'walking champions' and providing resources to encourage people to walk for all or some of their journey to work. Full details are reported elsewhere (Adams, 2012). Data used in this study were collected in the baseline survey which was conducted between December 2009 and June 2010. Overall, 5,512 employees were sent an invitation to complete the survey online and 1,544 employees responded (28% response rate). Ethical approval for this study was obtained from Loughborough University Ethical Advisory Committee (reference R09-P121).

### 2.2. Measure of commuter walking

Respondents were asked to report the number of minutes they spent walking to and from work separately for each day in the last week (adapted from the Transport and Physical Activity Questionnaire (Adams et al., 2014)). Total number of minutes spent walking to and from work in the past week was computed by summing the number of minutes spent walking to and from work for each day. As the data were positively skewed, a binary variable was computed for commuter walking. Respondents who reported doing some walking (> 0 min) on the journey to or from work in the past week were classified as 'commuter walkers', respondents reporting no walking (0 min) were classified as 'commuter non-walkers'. In addition, as Government recommendations suggest bouts of 10 min or more physical activity are needed to benefit health (Department of Health, 2011), any respondents in the commuter walking group who did not report doing at least 10 minutes walking for one journey (to or from work) on at least one day were reclassified as 'commuter non-walkers'.

### 2.3. Measures of perceptions of the environment in the workplace neighbourhood

Perceptions of the environment in the workplace neighbourhood were assessed using items selected from existing instruments whose reliability has previously been evaluated (Adams et al., 2013; Cerin et al., 2006; Ogilvie et al., 2008; Spittaels et al., 2010). Respondents were asked about ten items relating to walking and perceptions of the built environment in the workplace neighbourhood: 'Thinking about the area within a 10–15 minute walk from your workplace, how much do you agree with the following statements...': (1) There are convenient routes for walking; (2) There are suitable pavements for walking; (3) The pavements are well maintained; (4) There are safe places to cross the road; (5) \*It is unsafe to walk because of the traffic; (6) \*It is unsafe to walk because of the level of crime/antisocial behaviour; (7) Walking routes are generally well lit; (8) Walking routes are free of litter/graffiti; (9) Walking routes are well signposted; and (10) It is a pleasant environment for walking in. Response options were on a 4-point Likert scale from strongly disagree to strongly agree. Negatively worded items (marked \*) were recoded during data cleaning such that a high score equated to agreement with the statements. In addition, respondents were asked to what extent they agreed that 'There is convenient public transport so I can walk some of the way to and from work' with response options on a 4-point Likert scale from strongly disagree to strongly agree. Responses to each environmental item were collapsed so that those who 'strongly disagreed' or 'disagreed' were compared to those who 'agreed' or 'strongly agreed'.

### 2.4. Confounding variables

Possible confounders included sex, age, ethnic group, educational qualifications, number of children under 16, car ownership (or access to a car), distance lived from work, the availability of free car parking at work, the organisation the respondent is employed by and physical activity levels in the last week (assessed using the single item measure (Milton et al., 2011)). Physical activity levels were also assessed using the short International Physical Activity Questionnaire (IPAQ) with a reference period of 'usual week' (Craig et al., 2003).

## 2.5. Statistical analyses

Respondents with data for all variables were included in the analysis ( $n=676$ ). We built a series of multivariate logistic regression models to calculate the odds ratios of commuter walking associated with perceptions of the environment in the workplace 'neighbourhood' adjusted for identified confounders. We checked for effect modification and interactions between variables at each stage of the model (Altman, 1999). Variables found not to contribute to the prediction of the dependent variable were excluded from the final model. We assessed the relative contribution of each environmental variable to each final model's variance explained using the  $R^2$  statistic (Altman, 1999). Data were analysed in SPSS Statistics (version 22.0) (IBM SPSS Inc, Armonk, New York).

## 3. Results

Table 1 shows the individual and work-related characteristics for 676 participants (35.9% male; 37.7% aged < 30 years). Just over half of participants (52.1%) were classified as commuter walkers and on average they spent 152.3 (SD  $\pm$  102.7) minutes walking to or from work in the last week. While there was no statistical difference between the proportion of commuter walkers and non-walkers meeting the physical activity recommendations when physical activity was assessed using the single item measure (Milton et al., 2011), there were

**Table 1**  
Characteristics of respondents by commuter non-walkers, commuter walkers and overall.

Characteristic	Commuter non-walkers $n=324$		Commuter walkers $n=352$		p-Value	Overall $n=676$	
	n	%	n	%		n	%
<b>Sex</b>							
Female	200	61.7	233	66.2	.227	433	64.1
<b>Age (years)</b>							
< 30	91	28.1	164	46.6	< .001	255	37.7
30–44	135	41.7	113	32.1		248	36.7
$\geq$ 45	98	30.2	75	21.3		173	25.6
<b>Ethnic group</b>							
White	315	97.2	330	93.8	.031	645	95.4
<b>Education</b>							
Higher degree/degree	166	51.2	144	40.9	.013	310	45.9
GCE 'A' Level or equivalent	91	28.1	102	29.0		193	28.6
GCSE Grades A to C or equivalent	58	17.9	97	27.6		155	22.9
No formal qualification	9	2.8	9	2.6		18	2.7
<b>Children under 16</b>							
Yes	110	34.0	91	25.9	.021	201	29.7
<b>Car ownership/access</b>							
Yes	311	96.0	256	72.7	< .001	567	83.9
<b>Distance live from work</b>							
$\leq$ 2 mile	42	13.0	122	34.7	< .001	164	24.3
2.1–5 mile	86	26.5	116	33.0		202	29.9
5.1–10 mile	104	32.1	50	14.2		154	22.8
> 10 mile	92	28.4	64	18.2		156	23.1
<b>Free car parking at work</b>							
Yes	235	72.5	153	43.5	< .001	388	57.4
<b>Physical activity<sup>a</sup></b>							
Meeting recommendations <sup>b</sup>	79	24.4	87	24.8	.903	166	24.6
<b>Usual physical activity<sup>c</sup></b>							
Vigorous physical activity (mean minutes $\pm$ SD per week)	264	168.7 $\pm$ 181.3	280	177.4 $\pm$ 193.3	.449	544	173.1 $\pm$ 187.4
Moderate physical activity (mean minutes $\pm$ SD per week)	266	149.3 $\pm$ 190.4	289	194.9 $\pm$ 219.8	.002	555	173.0 $\pm$ 207.3
Walking (mean minutes $\pm$ SD per week)	314	306.4 $\pm$ 319.8	351	427.5 $\pm$ 369.9	< .001	665	370.3 $\pm$ 352.1
Total physical activity (mean minutes $\pm$ SD per week)	324	562.2 $\pm$ 472.9	352	727.4 $\pm$ 567.4	< .001	676	648.6 $\pm$ 530.5
<b>Organisation</b>							
A	25	7.7	19	5.4	< .001	44	6.5
B	115	35.5	196	55.7		311	46.0
C	84	25.9	42	11.9		126	18.6
D	88	27.2	80	22.7		168	24.9
E	12	3.7	15	4.3		27	4.0

<sup>a</sup> Assessed using the single item measure for physical activity (Milton et al., 2011).

<sup>b</sup> Equivalent of 150 min per week of moderate intensity physical activity (Department of Health, 2011).

<sup>c</sup> Assessed using the short form of the International Physical Activity Questionnaire (Craig et al., 2003).

**Table 2**  
Perceptions of environmental attributes in the workplace neighbourhood and likelihood of commuter walking.

Item	Commuter non-walkers n=324 n (% agree)	Commuter walkers n=352 n (% agree)	Commuter walking			
			Model 1 <sup>a,b</sup>		Model 2 <sup>a,c</sup>	
			OR (95% CI)	p-Value	OR (95% CI)	p-Value
Convenient routes for walking	260 (80.2)	309 (87.8)	1.77 (1.16–2.70)	<b>.008</b>	2.05 (1.23, 3.42)	<b>.006</b>
Suitable pavements for walking	275 (84.9)	324 (92.0)	2.06 (1.26–3.37)	<b>.004</b>	2.23 (1.23, 4.04)	<b>.008</b>
Pavements are maintained	254 (78.4)	296 (84.1)	1.46 (0.99–2.15)	.058	1.64 (1.02, 2.62)	<b>.039</b>
Safe places to cross roads	269 (83.0)	315 (89.5)	1.74 (1.11–2.72)	<b>.015</b>	1.48 (0.88, 2.51)	.144
Safe with regards to traffic	239 (73.8)	277 (78.7)	1.31 (0.92–1.87)	.133	1.36 (0.89, 2.06)	.157
Safe with regards to crime & anti-social behaviour	246 (75.9)	267 (75.9)	1.00 (0.70–1.42)	.982	1.19 (0.78, 1.81)	.414
Walking routes are well lit	262 (80.9)	297 (84.4)	1.28 (0.86–1.91)	.229	1.12 (0.70, 1.79)	.648
Walking routes are free of litter/graffiti	211 (65.1)	214 (60.8)	0.83 (0.61–1.14)	.245	0.82 (0.56, 1.20)	.301
Walking routes are well sign-posted	154 (47.5)	178 (50.6)	1.13 (0.84–1.53)	.430	1.05 (0.74, 1.51)	.781
Pleasant walking environment	180 (55.6)	220 (62.5)	1.33 (0.98–1.81)	.067	1.20 (0.82, 1.75)	.341
Convenient public transport	101 (31.2)	267 (75.9)	6.94 (4.94–9.73)	<b>&lt; .001</b>	4.98 (3.34, 7.44)	<b>&lt; .001</b>

OR=odds ratio; CI=confidence interval.

<sup>a</sup> Reference category is 'strongly disagree' or 'disagree'

<sup>b</sup> Crude unadjusted

<sup>c</sup> Adjusted for sex, age, car ownership, distance lived from work, free car parking at work and organisation.

significant differences between commuter walkers and non-walkers in total minutes of moderate intensity physical activity, walking and overall physical activity in a usual week assessed using the short IPAQ (Craig et al., 2003).

Compared to those included in the analysis, a higher proportion of excluded participants were female (72.5% vs. 64.1%,  $p < .001$ ), more participants were aged 30 or older (69.8% vs. 62.3%,  $p = .05$ ), a lower proportion had children under 16 (24.2% vs. 29.7%,  $p = .015$ ), a higher proportion had access to a car (89.3% vs. 83.9%,  $p = .003$ ), a lower proportion lived within 2 miles of work (18.7% vs. 24.3%,  $p = .004$ ) and a higher proportion reported having free car parking at work (70.5% vs. 57.4%,  $p < .001$ ). There were no significant differences in other demographic and work-related characteristics. Of the respondents who were excluded from the analysis ( $n = 868$ ), 513 (59.1%) provided data for total minutes of walking to and from work per week. Compared to those included in the analysis, a lower proportion of excluded participants were classified as commuter walkers (45.8% vs. 52.1%,  $p = .032$ ). On average commuter walkers who were excluded from the analysis spent 154.6 (SD  $\pm$  106.7) minutes walking to or from work in the last week.

Table 2 presents the crude unadjusted and adjusted odds ratios for commuter walking. Participants who reported there were convenient routes for walking, suitable pavements for walking and maintained pavements were significantly more likely to walk as part of their daily commute. Participants who reported there to be convenient public transport were almost five times more likely to walk for the daily commute. With the exception of walking routes being free from litter and graffiti, associations with the other environmental attributes and the likelihood of commuter walking were positive, however all were non-significant.

In unadjusted models, the pseudo- $R^2$  values indicate that individual environmental items explained between 0.0% and 1.7% of variance in commuter walking behaviour, whilst 25% might be explained by convenient public transport. When convenient public transport was added to the established main effects model the total variance in commuter walking that could be explained increased to 42.6%. The total variance that can be explained increased further to 44.7% when all environmental factors were also considered.

#### 4. Discussion

Reporting the presence of convenient routes and suitable, maintained pavements for walking in the workplace neighbourhood was associated with commuter walking. One previous study reported similar findings relating to the presence of sidewalks (pavements) (Schwartz et al., 2009), however direct comparisons are not possible as the previous study did not specifically assess time spent walking for the journey to and from work and the study was conducted in the US which may differ from the UK context in urban design.

In our study, reporting the availability of convenient public transport was associated with commuter walking. Similar findings have been reported elsewhere (Panter et al., 2011). Other studies support our results showing the contribution of walking as part of a journey and how linking with the use of public transport can result in higher levels of physical activity (Besser and Dannenberg, 2005; Freeland et al., 2013; Morency et al., 2011). This type of walking is not typically included in national transport surveys (Department for Transport, 2013) and our study shows that walking within commuting journeys may be underestimated. Providing convenient access to public transport close to workplaces is likely to be important for increasing commuter walking, and therefore overall physical activity levels, particularly for those who live too far away from work to walk for the entire journey and need to combine walking with other forms of transport.

##### 4.1. Study strengths and limitations

As far as we are aware, this is the first study to investigate the association between perceptions of the environment in the workplace neighbourhood and commuter walking. The strengths of our study include analysis of a specific behaviour (walking to and from work) in a specific context (around the workplace) to try and understand behaviour-specific environmental correlates of commuter walking. We used measures from existing instruments to assess commuter walking and perceptions of the environment (albeit in a different context) which have been tested for reliability. Data were collected over a six month period between December and June which may help to take into

account seasonal variations in travel behaviour. Respondents were from five different workplaces which may have provided some heterogeneity of workplace neighbourhoods.

Our study limitations included relying on self-report measures for assessing perceptions of the physical environment and commuter walking, which may have resulted in both error and bias in their measurement. It was not possible to use objective measures of walking and environmental attributes in our study due to financial constraints. The low response rate to the survey and differences in characteristics between those included in the analysis and those excluded may also have led to bias.

We defined a commuter walker as someone who had done 'some' walking to or from work in the last week, meaning the threshold for classifying participants as commuter walkers was quite low. In order to strengthen our criterion for commuter walking, we reclassified participants as commuter non-walkers if all walking journeys reported were less than ten minutes. This was to ensure commuter walkers had undertaken the current recommended minimum bout of activity to gain health benefits (Department of Health, 2011) and to exclude those who reported very short bouts of walking (e.g. 2 min walking, which might only be to travel from the workplace car park to the office building) from the commuter walker category. Although the threshold for classification as a commuter walker may still have been low, recent research has shown that even a small volume of weekly walking can benefit health and reduce the relative risk of all-cause mortality (Kelly et al., 2014).

In our study, we asked respondents about the environment within 10–15 minutes' walk of their workplace. By framing the question in this way, we might expect respondents to consider the whole area around their workplace that falls within this radius. It is however possible respondents might only consider the environment on the single route they use to travel to and from their workplace. We did not make any assessment of how this question was answered as part of our study but previous research suggests that "adults' interpretation of their neighbourhood area does not appear to relate accurately to the definitions typically used in research into environmental perceptions and walking" (Smith et al., 2010). Therefore further investigation may be needed to improve our understanding of how individuals respond to these types of questions.

We only asked about perceptions of the environment at the respondent's workplace. The residential neighbourhood environment and the route environment between the residential neighbourhood and the workplace may also be important in determining commuter walking behaviour, particularly for those who live long distances from their place of work. Further investigation is required to understand the factors affecting route choice between the residential neighbourhood and the workplace, and how the environments on different parts of the route may affect the mode of transport selected for the journey to and from work. Understanding differences in perceptions between those who live within walking distance of their workplace (< 2 mile), and those who live > 2 mile and would most likely have to use public or motorised transport as part of their journey, might also be important.

Commuter walking has the potential to increase to overall physical activity levels. Despite this, we found no significant difference in the proportion of commuter walkers and non-walkers meeting the physical activity recommendations when physical activity was assessed using the single item measure (Milton et al., 2011). This may reflect that individuals who meet the recommendations accumulate their physical activity in different ways, or that the measure was not sensitive enough to detect differences in commuter walking. To explore this further, we also assessed physical activity using the short IPAQ (Craig et al., 2003) and found significant differences between commuter walkers and non-walkers, with walkers reporting significantly higher levels of moderate intensity physical activity, walking and overall physical activity. Due to differences in the recall timeframe (IPAQ was assessed using 'usual week' and commuter walking was assessed using 'last week') we were unable to adjust total minutes of physical activity to take into account commuter walking and include it as a potential confounder in the analysis reported in this study. We did however test it in a sensitivity analysis and it did not affect the findings.

Other residual confounders, like non-environmental factors such as individual, social, psychological (e.g. attitudes to walking) and work-related factors (e.g. distance lived from work and the availability of free car parking), may be stronger predictors of commuter walking and these remain important areas for continued research. We did examine personal attitudes to walking in our study and found there were no significant differences between commuter walkers and non-walkers in perceptions that walking is enjoyable, improves health, is good exercise or is good for the environment. We therefore did not include these factors in our analysis.

Finally, due to the cross sectional nature of our study, we are unable to infer causal relationships between perceptions of the environment and commuter walking.

#### 4.2. Implications for practice and policy

Our findings have important implications for transport and planning practice and policy as well as employers. Locating new workplaces in 'pedestrian friendly' environments, improving pedestrian environments around existing workplaces and providing suitable access to public transport is important for promoting commuter walking. These findings support previous recommendations (National Institute for Health and Care Excellence, 2008; National Institute for Health and Care Excellence, 2012) and provide further evidence of the need for investment to develop a comprehensive network of walking routes which provide convenient access to existing and new workplaces. In the UK, this need has recently been recognised by the inclusion of walking (and cycling) under the Infrastructure Act 2015 (UK Parliament, 2015). This act outlines the Government's plans to improve the transport system and sets out the legal requirement to develop a strategy for investment in walking and cycling infrastructure. The findings from our study suggest workplace neighbourhoods should be considered as a priority area for investment in the development and maintenance of pedestrian infrastructure to support an increase in commuter walking.

Our study also provides further support for previous recommendations that employers and employees should work with local authorities, neighbouring workplaces and other partners to improve walking access to workplaces (National Institute for Health and Care Excellence, 2012). Employers should play a role in educating their employees with regard to the availability of convenient, safe and suitable walking routes in the areas surrounding their workplaces, including how the routes integrate with public transport links, in order to increase employee knowledge of the local area and promote commuter walking (National Institute for Health and Care Excellence, 2012). This has potential benefits for employers by alleviating pressures on car parking at work as well as improving the health of their employees by helping them to become more physically active.

## 5. Conclusion

Encouraging commuter walking is a potential strategy for increasing physical activity levels. Our study suggests that providing convenient, suitable and maintained pedestrian infrastructure, as well as access to public transport, in the workplace neighbourhood is associated with commuter walking. In practice, creating 'pedestrian friendly' environments in workplace surroundings along with convenient access to public transport may be important for reducing car use and encouraging commuter walking in order to increase physical activity levels. Improving and maintaining the walking environment around existing workplaces and ensuring infrastructure around new workplaces is designed to support commuter walking should be considered a priority area for investment.

## Acknowledgements

The lead author was commissioned by Living Streets to undertake an independent evaluation of their Walking Works Pathfinder Employers Scheme. Living Streets is a national charity working to create safe, attractive and enjoyable streets around the UK. The Walking Works project was managed and delivered by Living Streets as part of a portfolio of projects being delivered by a Consortium of the leading walking, cycling and health organisations in England and funded through the Big Lottery Fund Wellbeing Programme. We thank the study participants for taking part in this project. The views expressed in this paper are those of the authors and do not necessarily reflect those of the study funders.

## References

- Department of Health, 2011. Start Active, Stay Active: A Report on Physical Activity From the Four Home Countries' Chief Medical Officers. Department of Health, London, UK.
- Kelly, P., Kahlmeier, S., Goetschi, T., Orsini, N., Richards, J., Roberts, N., et al., 2014. Systematic review and meta-analysis of reduction in all-cause mortality from walking and cycling and shape of dose response relationship. *Int. J. Behav. Nutr. Phys. Act.* 11, 132.
- Craig, R., Mindell, J., 2013. Health Survey for England 2012. Health and Social Care Information Centre, Leeds, UK.
- Allender, S., Foster, C., Scarborough, P., Rayner, M., 2007. The burden of physical activity-related ill health in the UK. *J. Epidemiol. Community Health.* 61, 344–348.
- Scarborough, P., Bhatnagar, P., Wickramasinghe, K.K., Allender, S., Foster, C., Rayner, M., 2011. The economic burden of ill health due to diet, physical inactivity, smoking, alcohol and obesity in the UK: an update to 2006–07 NHS costs. *J. Public Health.* 33, 527–535.
- Department for Transport, 2013. National Travel Survey England 2013. Department for Transport, London, UK.
- Office for National Statistics, 2011. Method of Travel to Work in England and Wales – 2011. (<http://www.ons.gov.uk/ons/rel/census/2011-census-analysis/method-of-travel-to-work-in-england-and-wales/sty-method-of-travel-to-work.html>).
- Department for Transport, 2011. Creating Growth, Cutting Carbon: Making Sustainable Local Transport Happen. Department for Transport, London, UK.
- Sallis, J.F., Bauman, A., Pratt, M., 1998. Environmental and policy – interventions to promote physical activity. *Am. J. Prev. Med.* 15, 379–397.
- Adams, E.J., Goodman, A., Sahlqvist, S., Bull, F.C., Ogilvie, D., 2013. iConnect Consortium, 2013. Correlates of walking and cycling for transport and recreation: factor structure, reliability and behavioural associations of the perceptions of the environment in the neighbourhood scale (PENS). *Int. J. Behav. Nutr. Phys. Act.* 10, 87.
- Owen, N., Humpel, N., Leslie, E., Bauman, A., Sallis, J.F., 2004. Understanding environmental influences on walking – review and research agenda. *Am. J. Prev. Med.* 27, 67–76.
- Saelens, B.E., Sallis, J.F., Frank, L.D., 2003. Environmental correlates of walking and cycling: findings from the transportation, urban design, and planning literatures. *Ann. Behav. Med.* 25, 80–91.
- Saelens, B.E., Handy, S.L., 2008. Built environment correlates of walking: a review. *Med. Sci. Sport. Exerc.* 40 (Suppl.), S550–S566.
- Van Dyck, D., Cerin, E., Conway, T.L., De Bourdeaudhuij, I., Owen, N., Kerr, J., et al., 2012. Perceived neighborhood environmental attributes associated with adults' transport-related walking and cycling: findings from the USA, Australia and Belgium. *Int. J. Behav. Nutr. Phys. Act.* 9, 70.
- Van Holle, V., Deforche, B., Van Cauwenberg, J., Goubert, L., Maes, L., Van de Weghe, N., et al., 2012. Relationship between the physical environment and different domains of physical activity in European adults: a systematic review. *BMC Public Health* 12, 807.
- Giles-Corti, B., Timperio, A., Bull, F., Pikora, T., 2005. Understanding physical activity environmental correlates: increased specificity for ecological models. *Exerc. Sport Sci. Rev.* 33, 175–181.
- Adlakha, D., Hipp, A.J., Marx, C., Yang, L., Tabak, R., Dodson, E.A., et al., 2015. Home and workplace built environment supports for physical activity. *Am. J. Prev. Med.* 48, 104–107.
- Schwartz, M.A., Aytur, S.A., Evenson, K.R., Rodriguez, D.A., 2009. Are perceptions about worksite neighborhoods and policies associated with walking? *Am. J. Health Promot.* 24, 146–151.
- Adams, E.J., 2012. Evaluation of Living Streets' Walking Works Pathfinder Employers Scheme. BHF National Centre for Physical Activity and Health, Loughborough University, Loughborough, UK.
- Adams, E.J., Goad, M., Sahlqvist, S., Bull, F.C., Cooper, A.R., Ogilvie, D., et al., 2014. Reliability and validity of the transport and physical activity questionnaire (TPAQ) for assessing physical activity behaviour. *Plos One* 9, e107039.
- Cerin, E., Saelens, B.E., Sallis, J.F., Frank, L.D., 2006. Neighborhood environment walkability scale: Validity and development of a short form. *Med. Sci. Sport. Exerc.* 38, 1682–1691.
- Ogilvie, D., Mitchell, R., Nutrie, N., Petticrew, M., Platt, S., 2008. Perceived characteristics of the environment associated with active travel: development and testing of a new scale. *Int. J. Behav. Nutr. Phys. Act.* 5, 32.
- Spittaels, H., Verloigne, M., Gidlow, C., Gloanec, J., Titze, S., Foster, C., et al., 2010. Measuring physical activity-related environmental factors: reliability and predictive validity of the European environmental questionnaire ALPHA. *Int. J. Behav. Nutr. Phys. Act.* 7, 48.
- Milton, K., Bull, F.C., Bauman, A., 2011. Reliability and validity testing of a single-item physical activity measure. *Br. J. Sports Med.*, 45.
- Craig, C.L., Marshall, A.L., Sjostrom, M., Bauman, A.E., Booth, M.L., Ainsworth, B.E., et al., 2003. International physical activity questionnaire: 12-country reliability and validity. *Med. Sci. Sports Exerc.* 35, 1381–1395.
- Altman, D., 1999. Practical Statistics for Medical Research. Chapman & Hall/CRC, London.
- Panther, J., Griffin, S., Jones, A., Mackett, R., Ogilvie, D., 2011. Correlates of time spent walking and cycling to and from work: baseline results from the commuting and health in Cambridge study. *Int. J. Behav. Nutr. Phys. Act.* 8, 124.
- Besser, L.M., Dannenberg, A.L., 2005. Walking to public transit steps to help meet physical activity recommendations. *Am. J. Prev. Med.* 29, 273–280.
- Freeland, A.L., Banerjee, S.N., Dannenberg, A.L., Wendel, A.M., 2013. Walking associated with public transit: moving toward increased physical activity in the United States. *Am. J. Public Health.* 103, 536–542.
- Morency, C., Trepanier, M., Demers, M., 2011. Walking to transit: an unexpected source of physical activity. *Transp. Policy.* 18, 800–806.
- Department for Transport, 2013. National Travel Survey 2013 Notes and Definitions. London, UK: Department for Transport.
- Smith, G., Gidlow, C., Davey, R., Foster, C., 2010. What is my walking neighbourhood? A pilot study of English adults' definitions of their local walking neighbourhoods. *Int. J. Behav. Nutr. Phys. Act.* 7, 34.
- National Institute for Health and Care Excellence, 2008. Physical Activity and the Environment. National Institute for Health and Care Excellence, Manchester, UK.
- National Institute for Health and Care Excellence, 2012. Walking and Cycling: Local Measures to Promote Walking and Cycling as Forms of Travel or Recreation. National Institute for Health and Care Excellence, Manchester, UK.
- UK Parliament. Infrastructure Act 2015. (<http://services.parliament.uk/bills/2014-15/infrastructure.html>).