



## Does More Cycling Mean More Diversity in Cycling?

Rachel Aldred, James Woodcock & Anna Goodman

To cite this article: Rachel Aldred, James Woodcock & Anna Goodman (2016) Does More Cycling Mean More Diversity in Cycling?, *Transport Reviews*, 36:1, 28-44, DOI: [10.1080/01441647.2015.1014451](https://doi.org/10.1080/01441647.2015.1014451)

To link to this article: <https://doi.org/10.1080/01441647.2015.1014451>



© 2015 The Author(s). Published by Taylor & Francis



Published online: 25 Feb 2015.



Submit your article to this journal [↗](#)



Article views: 12380



View related articles [↗](#)



View Crossmark data [↗](#)



Citing articles: 58 View citing articles [↗](#)

## Does More Cycling Mean More Diversity in Cycling?

RACHEL ALDRED\*<sup>§</sup>, JAMES WOODCOCK\*\* AND ANNA GOODMAN<sup>†</sup>

*\*Department of Planning and Transport, Faculty of Architecture and the Built Environment, University of Westminster, Marylebone Campus, 35 Marylebone Road, London NW1 5LS, UK;*

*\*\*UKCRC Centre for Diet and Activity Research (CEDAR), MRC Epidemiology Unit, University of Cambridge School of Clinical Medicine, Box 285 Institute of Metabolic Science, Cambridge Biomedical Campus, Cambridge CB2 0QQ, UK; <sup>†</sup>Faculty of Epidemiology and Population Health, London School of Hygiene and Tropical Medicine, Keppel Street, London WC1E 7HT, UK*

*(Received 21 July 2014; revised 19 December 2014; accepted 28 January 2015)*

**ABSTRACT** *In low-cycling countries, cycling is not evenly distributed across genders and age groups. In the UK, men are twice as likely as women to cycle to work and cycling tends to be dominated by younger adults. By contrast, in higher cycling countries and cities, gender differences are low, absent, or in the opposite direction. Such places also lack the UK's steady decline in cycling among those aged over 35 years. Over the past fifteen years some UK local areas have seen increases in cycling. This paper analyses data from the English and Welsh Census 2001 and 2011 to examine whether such increases are associated with greater diversity among cyclists. We find that in areas where cycling has increased, there has been no increase in the representation of females, and a decrease in the representation of older adults. We discuss potential causes and policy implications. Importantly, simply increasing cycling modal share has not proved sufficient to create an inclusive cycling culture. The UK's culturally specific factors limiting female take-up of cycling seem to remain in place, even where cycling has gone up. Creating a mass cycling culture may require deliberately targeting infrastructure and policies towards currently under-represented groups.*

### Introduction

The potential benefits of a shift towards greater levels of walking and/or cycling are large (Woodcock, Givoni, & Morgan, 2013). Major health benefits could be realised, primarily due to physical activity; additional cited benefits include positive impacts upon local economies, reduction in carbon dioxide emissions, and better air quality in cities (Aldred, 2012). In the UK, however, greater policy support for cycling has not led to substantial increases either in levels of funding or in cycling uptake at the national level.

Despite this, areas in the UK differ considerably in absolute cycling levels and in rates of change. Similarly, while investment in cycling overall has been low, some

---

<sup>§</sup>Corresponding author. Email: [r.aldred@westminster.ac.uk](mailto:r.aldred@westminster.ac.uk)

areas have chosen to spend more or have successfully applied for additional central funding. This provides the opportunity to explore whether those areas that have successfully achieved a modal shift towards cycling have also created a cycling that is more equal. Are women becoming better represented, or do new users look very much like existing users? A similar question can be asked with relation to age: Is cycling becoming more evenly distributed by age group?

To answer this question, the paper uses 2001 and 2011 Census data on levels of cycling to work by English and Welsh local authority. Our primary aim is to examine whether changes in cycling levels between 2001 and 2011 are associated with changes in the gender and age balance of cycling. To set these findings in context, we also present cross-sectional correlations between cycle commuting levels and gender and age equity at each time point. We consider different potential explanations for our findings and suggest implications for policy and further research.

## Literature Review

### *Cycling, Gender, and Age: National and International Context*

Levels of cycling to work are low in the UK relative to Germany, Denmark, and the Netherlands and have been stuck at around 3% of all commute journeys for 20 years, albeit with substantial local variation (Goodman, 2013). In addition, commuter cycling in the UK is concentrated among specific demographic groups, with regular commuters more likely to be male, white, able-bodied, and young (Sport England/DfT, 2014; Steinbach, Green, Datta, & Edwards, 2011; Transport for London [TfL], 2012a).

This gender differential is culturally specific and most pronounced in low-cycling, English-speaking countries. Pucher and Buehler's (2008) overview showed that Australia, the UK, the USA, and Canada all have women's participation at 30% or less, as opposed to 45% or more in higher cycling Germany, Denmark, and the Netherlands. High-cycling countries and cities are also generally agreed to have relatively high-quality cycling infrastructure and good cultural support for cycling (e.g. Heinen & Handy, 2012).

In high-cycling countries, where gender differences exist, women tend to cycle *more* than men. In Ghent, in the Flanders region of Belgium, women cycle more than men within the 20–65 age group (Witlox & Tindemans, 2004). Recent data from the Netherlands show that women's cycling mode share is higher than men's for commute and shopping trips; and similar for leisure and educational trips (Harms, Bertolini, & te Brömmelstroet, 2014).

Relationships between age and cycling have generally received less attention but are potentially even more important given that the health benefits of cycling are the largest at older ages (Woodcock, Tainio, Cheshire, O'Brien, & Goodman, 2014). In England and Wales, cycle commuting levels fall with age, particularly in London. Outside London, around 3% of commuters cycle to work between 30 and 39 years of age, with a slow decline to 1.6% for 65+ years. Within London, a peak of 5.3% in the 30–39 age group declines more sharply to 1.3% for 65+ years (Office for National Statistics [ONS], 2014, p. 34). A Transport for London survey reports that only 1 in 20 Londoners aged 65+ ever cycles for any purpose (utility or leisure), compared with at least 1 in 7 in all other age groups (TfL, 2012a). Similarly in the Active People Survey, overall cycling levels are broadly similar for age groups between 16 and 54 (men 22–27%, women

11–14%) years, but older age groups see a decline, with only 15% of men aged 55–64 years ever cycling, and only 8% of men over 65 years cycling (Sport England/DfT, 2014). For women these latter two figures are 7% and 3%, respectively.

In higher cycling countries, age gradients exist, but their direction varies and the proportion of trips cycled in older age groups remains high:

In Germany, the bike share of trips rises steadily from 7% among 18–24-year-olds to 12% for those 65 and older. The bike share of trips declines with age in Denmark, but even among those aged 70–74 years old, cycling accounts for 12% of all trips, the same as among Germans who are 65 and older. The Dutch elderly double that percentage, making 24% of all their trips by bike. (Pucher & Buehler, 2008, p. 504)

This Dutch percentage of 24% for over-65 years is higher than the percentage reported for any other age group over the age of 26 years.

In summary, in a broader Western European context we find substantial variation in gender and age differences in cycling participation. This includes, in high-cycling contexts, settings where no large differences exist or where women and older people are *over*-represented (Heinen, van Wee, & Maat, 2010). The UK, however, is similar to other English-speaking, low-cycling countries in having relatively high levels of inequality, with women and older people disproportionately under-represented. The health and other implications of these inequities have caused concern. Buehler, Pucher, Merom, and Bauman (2011, p. 245) write, comparing Germany and the USA:

German percentages of 30 minutes of daily active travel are five times higher for seniors (34.3% vs 6.3%) and more than three times as high for children (30.3% vs 8.6%) and women (29.3% vs 8.2%). The inequitable distribution of active travel in the U.S. suggests the need for targeted policies to increase walking and cycling among seniors, children, and women, in particular.

The past decade has, however, seen a substantial increase in UK policy interest in promoting cycling (Butcher, 2012), as well as increased cycling levels in some cities (Goodman, 2013). This latter is a pattern seen in a range of countries, and may be linked both to ‘push’ and ‘pull’ factors. ‘Push’ factors may include what has been termed ‘Peak Car’ (Parliamentary Office for Science and Technology, 2013), which is associated with a shift away from car ownership and use among city dwellers. In cities such as London, the ‘pull’ factors may include the time and reliability advantages of the bicycle in the context of high levels of congestion on roads and public transport.

In recent years, policy-makers and campaigners have recognised the importance of making cycling more inclusive, and thereby enabling a transition to a mass-cycling culture (Department for Transport, 2011; Greater London Authority [GLA], 2013). As Handy, van Wee, and Kroesen (2014, p. 18) comment, “it is important that [cycling] researchers connect their efforts to the questions that policy-makers are asking”. The cross-sectional data imply that as cycling rises we should expect it to become more equal (Sport England/DfT, 2014, p. 6). Hence we seek to examine whether this is actually the case or whether a more targeted approach needs to be taken to getting women and older people cycling.

### *Gender Equity and Cycling*

Before examining data on equity and uptake, we review academic literature explaining the current inequalities. What factors are put forward to account for the fact that in lower cycling countries, women cycle less than men? Broadly speaking, there are three types of reason, related to trip characteristics, cultural norms, and infrastructural preferences. Writing from the USA, Krizek, Johnson, and Tilahun (2006, p. 32) state that while women may have shorter trip distances than men (see also Dickinson, Kingham, Copsey, & Pearlman, 2003) “equally compelling reasoning suggests that women should have lower rates of cycling than men”. They cite escort trips, multi-purpose, and/or encumbered trips as journeys that women are particularly likely to make, which are all less suited for bicycle travel than journeys by ‘typical commuters’ travelling alone and unencumbered from A to B.

Similarly in London, Transport for London’s Cycling Potential Analysis (2010<sup>1</sup>) defines journeys travelling with children or heavy objects as not potentially cycleable. Yet in the Netherlands, where such trips are all pictured in the national design manual, these assumptions would seem odd. As Garrard, Handy, and Dill (2012) comment, it clearly is possible to create cycling environments that better support escort, multi-purpose, and/or encumbered trips. For example, in the Dutch context, women are more distance-sensitive than men for commuter cycling (Heinen, Maat, & van Wee, 2013). Minimising the impact of distance, through for example high-quality surfacing on cycle tracks or priority at junctions could therefore be particularly important for women (as well as for anyone carrying children or goods).

The second set of reasons why women may cycle less than men involves cultural norms. As Rietveld and Daniel (2004, p. 531) argue, “cultural tradition [...] deserves a more explicit role in [...] the analysis of travel behaviour than it usually receives”. Krizek et al. (2006) argue that greater risk aversion among women would lead to lower adoption. Attributes associated with cycling in low-cycling contexts, such as risk tolerance and sportiness (Garrard et al., 2012; Horton, 2007; Rissel, Bonfiglioli, Emilsen, & Smith, 2010) may be disproportionately off-putting for women. Out-group stereotypes and experiences of marginalisation can be mutually reinforcing, acting to further exclude under-represented groups (Aldred, 2013; Steinbach et al., 2011).

This is linked to the third group of explanations, around attitudes towards infrastructure and cycling environments (Krizek et al., 2006). There is a growing academic consensus that people in general prefer “less interactions with [motor] traffic and riding in safer conditions” (Wang, Mirza, Cheung, & Moradi, 2012; see also Caulfield, Brick, & McCarthy, 2012 [Ireland]; TfL, 2012b [UK]; Winters & Teschke, 2010 [Canada]; Björklund & Isacson, 2013 [Sweden]). Yet while a preference for segregation from motor traffic may be common across the genders, most studies indicate that its strength is greater in women (e.g. Beecham & Wood, 2014 [UK]; Garrard, Rose, & Lo, 2008 [Australia]; Heesch, Sahlqvist, & Garrard, 2012 [Australia]; Krizek et al., 2006 [USA]; Twaddle, Hall, & Bracic, 2010 [Canada] — but see Broach, Dill, & Gliebe, 2012 [USA] for an exception).

### *Age Equity and Cycling*

Promoting cycling at older ages is arguably a priority for a ‘healthy’ transport system because net health benefits of cycling rise with age (Woodcock et al.,

2014). In London, three-quarters of those aged 65 years and over can ride a bicycle, but only 6% of those who can ever do, while for all Londoners who can ride, the figure is 21%<sup>2</sup> (TfL, 2012a). Yet age remains poorly researched in relation to adult cycling. In relation to commuting, Pooley and Turnbull (2000, p. 19) state that “cycling is likely to become increasingly unattractive as [most workers] get older”. While they do not explain why, it is likely that they are expressing a common assumption that many older people are inherently incapable of riding (e.g. Armstrong, 2013).

However, age inequalities as detailed above are culturally specific, not universal. Moreover, some trip-related factors might be expected to *encourage* cycling at older ages. This might include shorter typical commutes (Department for Transport [DfT], 2013) and a lower likelihood of needing to combine commute and escort trips. These factors are perhaps at work in Germany and the Netherlands, where cycling does indeed become increasingly popular at older ages, at least until age 75. On the other hand, there are a higher proportion of shopping trips among older adults and therefore potentially more “encumbered” trips (DfT, 2013).

As with gender inequalities, factors related to cultural norms and to infrastructure may be important. First, older adults may also be put off the image of cycling as being for “sporty” individuals (Rissel et al., 2010). Second, studies examining cycling preference and choices by age indicate that older adults may have stronger preferences for segregation from motor traffic. A Danish survey found that older people saw cycle paths as more important than did younger groups, and that “[t]he amount of traffic is not as important for the younger group as it is for the older group” (Bernhoft & Carstensen, 2008, p. 90). TfL (2012b) found similar differences by age group in relation to some (but not all) measures testing people’s preferences for riding away from motor traffic.

Finally, two further age-specific factors might lead to comparatively slower uptake of cycling among older adults. One is a greater tendency for younger adults to be ‘early-adopters’ of new behaviours or technologies (Rogers, 1995). The second is the potential for younger adults more often to experience life changes such as moving house or changing jobs, which can trigger a change in the commute mode (Clark, Chatterjee, Melia, Knies, & Laurie, 2014). Therefore, if cycling were increasing, one might expect any increasing uptake by older people to be subject to a lag, more so than in the case of gender.

### *Increasing Cycling, Increasing Equity?*

In this brief review, we have outlined (a) cross-sectional differences in gender and age equity in cycling and (b) possible reasons for inequalities in lower cycling contexts. Cross-sectional studies have identified a country- and city-level association between higher cycling levels and greater age and gender equity. Given this, we have suggested that differing trip types and levels of physical ability are unsatisfactory primary explanations for the lower participation of women and older people. Instead, infrastructural and cultural barriers appear more fundamental, albeit interacting with each other and with trip characteristics and physical ability levels in a way that may compound exclusion.

In lower cycling countries, there is then a question about the extent to which policy should focus explicitly on under-represented groups. Sport England/DfT (2014, p. 6) in reporting on gender equity argues that: “The ratio of men to

women also varies depending on the overall level of cycling: i.e. it would appear that *getting more men to cycle to work* encourages gender equality on this measure” (our emphasis). The implication here is that focusing on changes that might get men cycling will be sufficient to ensure that women also take up cycling. Looking at the cross-sectional country-level data, one might make a similar argument in relation to older people and younger people.

We can follow the argument with the example of improved cycle infrastructure, widely agreed to be an important part of strategies to increase cycling. Both men and women tend to prefer separation for motor traffic; however, studies suggest that women’s preferences are, on average, stronger. If Sport England/DfT (2014) is correct, greater gender equity might be achieved by building for men’s (on average, less stringent) preferences, perhaps through making relatively minor changes to road layouts. Greater gender equity might then happen through broader cultural normalisation; that is, more cycling generally would help to make it more acceptable for women, despite differences in their stated preferences. By contrast, if the key to getting women cycling is *building specifically for women’s (on average, more stringent) preferences*, then *getting more men cycling to work* will not necessarily encourage gender equity. Providing some limited and lower segregation infrastructure might increase cycling, particularly in a culturally favourable context (e.g. with falling car ownership and use, as in London) but without improving gender equity.

## Methods

At the national level, the UK has seen little change in cycling. However, substantial local variation in cycling levels and in changes in cycling uptake provide an opportunity to explore what has happened as cycling levels change. To answer this question, we chose to analyse 2001 and 2011 Census data, for which cross-tabulations are available by travel to work mode, by age group, and by gender.

### *Census Data on Main Commute Mode in England and Wales*

The UK Census happens every ten years and is compulsory for all residents, although its future after 2011 is in doubt. In England and Wales (the two UK countries for which suitable data are currently available), the estimated proportion of people covered by the census was 94% in both 2001 and 2011 (ONS, 2012). In the 2001 and 2011 census, all respondents aged 16–74 years with a current job were asked “How do you usually travel to work? (Tick one box only, tick the box for the longest part, by distance, of your usual journey to work)”. One of the response options was “bicycle”.

Clearly the Census data are limited in terms of transport information. They give a snapshot of people’s perception of their usual travel mode at a point in time, but do not capture individuals who only sometimes commute by bicycle or who cycle for other purposes. Where bicycle trips form part of a multi-modal commute, the ‘main mode’ selected is likely to be another mode. The result is that the Census question picks up an estimated 31% of the total time which adults in England and Wales spend cycling (Goodman, 2013).

On the other hand, at the population level there is a 0.77 correlation between the proportion of adults who choose cycling as their ‘usual main commute mode’ and the modal share of cycling as a proportion of total travel time (Goodman, 2013).

Thus although only a third of adult cycling is directly measured by the Census, this does at the population level provide a good proxy for total levels of cycling. Moreover, because the Census covers everyone, it is particularly suitable for exploring minority participation in minority modes at the local level: this would not be possible with a sample survey such as the National Travel Survey or the Active People Survey.

The 2011 data on travel to work are available stratified by sex and by age (in five-year age categories) at <https://www.nomisweb.co.uk/census/2011>. The smallest geographical area for which cross-tabulated data are available is the local authority. In 2011, there were 346 large local authorities in England and Wales (population range 11 600–392 500 commuters); we combined two additional very small local authorities (population  $\leq 7000$ ) with neighbouring authorities.<sup>3</sup> The 2001 data on travel to work are available stratified by age and sex at the output area level (population around 300) at <http://casweb.mimas.ac.uk>. We used the 2001 output areas to create geographical areas which mapped onto the 2011 local authority boundaries, allowing us to compare identical geographical areas over time. Ethical approval was not required as all data are fully in the public domain and non-identifiable.

#### *Cycle Modal Share and Gender and Age Ratios*

For each of the 346 local authorities and in both 2001 and 2011, we first calculated the total modal share of cycling as a proportion of all commuters, that is, excluding people not in work or people working at or from home. All adults reporting that their home address was also their place of work were treated as non-commuters.

Next, we calculated the ratio of ‘females among cyclist commuters’ to ‘all female commuters’ as follows: (percentage of females among cyclist commuters)/(percentage of females among all commuters). For example, in 2011 in the local authority of Adur the percentage of females among cyclist commuters was 27.7% and the percentage of females among all commuters was 48.7%, giving a ratio of  $27.7/48.7 = 0.57$ . We used this ‘ratio of female cyclists’ rather than ‘percentage of cyclists who are female’ to take account of modest variation between local authorities in the overall gender balance of commuters, and also some secular changes between 2001 and 2011 in the composition of the workforce.

We then repeated the above process to create a ratio of ‘percentage of older commuters among cyclist commuters’ to ‘percentage of older commuters among all commuters’. We defined ‘older commuters’ as 55–74 years old; our findings were similar in sensitivity analyses which instead defined these adults as 50–74 years or as 60–74 years. For both the gender and the age ratios, a value of under 1 would indicate an under-representation of women/older people among cyclists in that local authority (relative to the demographic composition of commuters as a whole), while a value over 1 would indicate an over-representation.

#### *Statistical Analyses*

In all analyses, our units of analysis were local authorities. We chose this approach because we view the phenomenon under analysis as ecological — that is to say, that women and men are responding to characteristics of their local area in deciding whether to cycle. For much of England and Wales, most commutes that may currently or potentially be cycled will occur mostly or entirely within a local



authority boundary (although this is less the case in London). We note that while population size varies by local authority, all are large and most are roughly comparable (median size 53 600 commuters in 2011, interquartile range 41 400–87 400). Our findings were unchanged in sensitivity analyses which weighted local authorities according to their population sizes.

The census data-set covers all local authorities, and 94% of the resident population within authorities. Despite this, we decided to treat these authorities as a sample and used inferential statistics (e.g. confidence intervals) to describe the patterning of cycling across authorities. We did this because we conceptualised ‘what actually happened’ as being drawn stochastically from a larger set of ‘things that might have happened’ based on underlying processes that shape probability distributions. Hence the inferential statistics allow us to draw conclusions about whether any observed pattern is likely to have arisen by chance, rather than being an expression of real underlying processes.

We first present cross-sectional analyses for 2001 and for 2011, showing the overall commute modal share of cycling plotted against the mean ratio of (a) female cyclists and (b) older adult cyclists. We used these cross-sectional results to calculate the average change in these two outcome ratios per 1-percentage-point absolute increase in the overall modal share of cycling. This represented a measure of how these ratios were affected by cross-sectional differences in cycling levels between local authorities. To examine whether the pattern was the same at both time points, we tested for interactions between year and the overall commute modal share of cycling, in linear regression models in which our outcome was either the female or the older adult ratio.

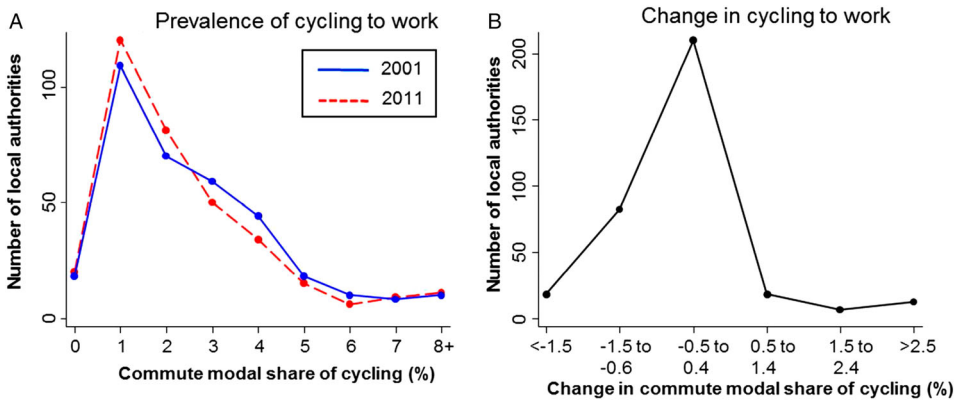
Next, we calculated the change in each local authority in overall cycling modal share from 2001 to 2011, and the changes in each local authority in the ratios of female cyclists and older adult cyclists. This allowed us to estimate how our two outcome ratios were affected by longitudinal differences in cycling levels within the same local authority. We then compared the magnitude of this average longitudinal effect within a local authority with the estimated cross-sectional effect between local authorities. All analyses used Stata 13.1.

Finally, we present some results focusing specifically on Inner London. We did this because Inner London has enjoyed substantially increased cycling investment over the past decade (from a low base) and is where many of the largest increases in cycling have taken place. This allows us to examine in more detail any changes in age and gender representation that happened in a high-profile ‘cycling success story’.

## **Results**

### *Changes in Levels of Cycling to Work*

Overall in England and Wales the prevalence of cycling to work rose from 3.0% in 2001 to 3.1% in 2011. [Figure 1](#) shows the distribution of cycling modal share across the 346 local authorities in England and Wales, and the distributions of change over time. This reveals that overall levels of cycling are (a) low and (b) stagnant or declining in most parts of England and Wales. However, [Figure 1](#) also highlights that there are a few areas which have high cycling levels and/or which have seen non-trivial increases in cycling over the past decades. The small positive



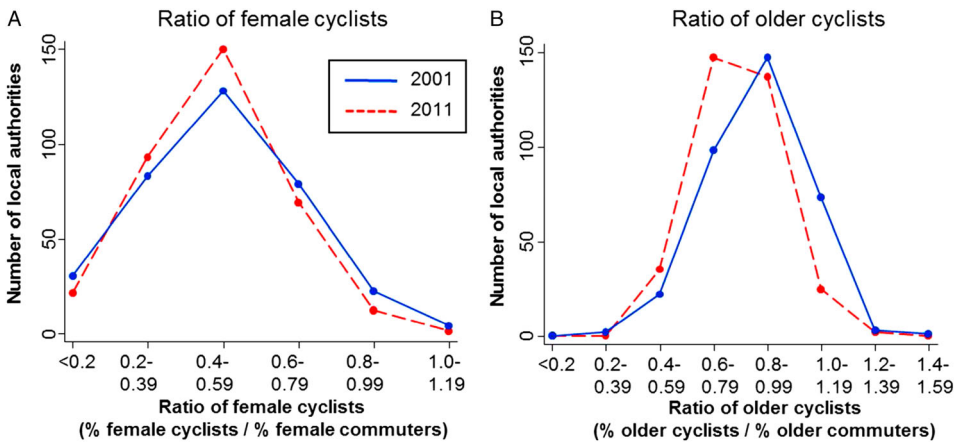
**Figure 1.** Cycling modal share across local authorities in England and Wales in 2001 and 2011, and change in prevalence of cycle modal share from 2001 to 2011.

overall change is due to a small group of local authorities having experienced substantial increases.

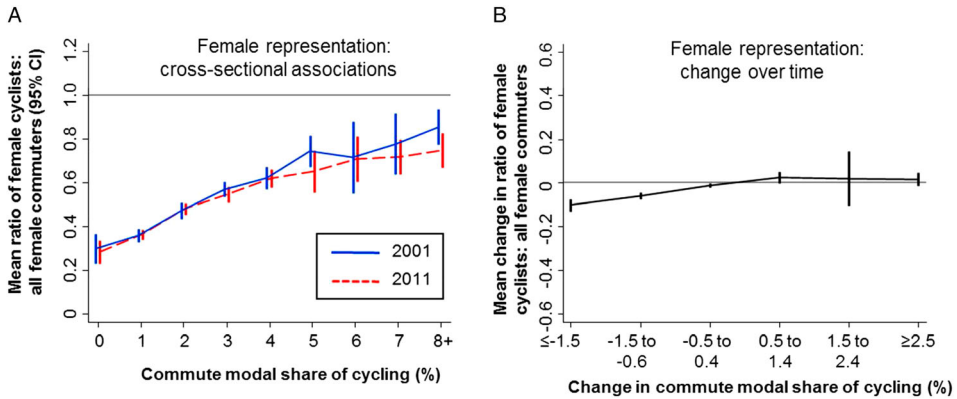
*Gender Equity and Cycling*

For England and Wales as a whole, the female ratio for cycle commuting was 0.48 in 2001 and 0.47 in 2011: thus as with the overall picture for cycle commuting, the gender ratio changed very little. **Figure 2(A)** shows the distribution of this female ratio among local authorities. This highlights the norm of substantial female under-representation, and also shows that a minority of local authorities has extreme levels of gender inequality (lower than 0.2 in 21 authorities in 2011). At the other end of the scale, another minority has reached relative gender equality (gender ratio > 0.8 in 13 local authorities in 2011, of which one had a ratio of just over 1 [1.01 in East Cambridgeshire]).

The cross-sectional results showed strong evidence that a higher modal share of cycling was associated with a higher representation of females among cyclists



**Figure 2.** Distribution of ratios of (A) female cyclists and (B) older adult cyclists across 346 local authorities in England and Wales in 2001 and 2011.



**Figure 3.** Representation of females among cyclists across 346 local authorities in England and Wales according to the overall modal share of cycling, cross-sectionally and over time.

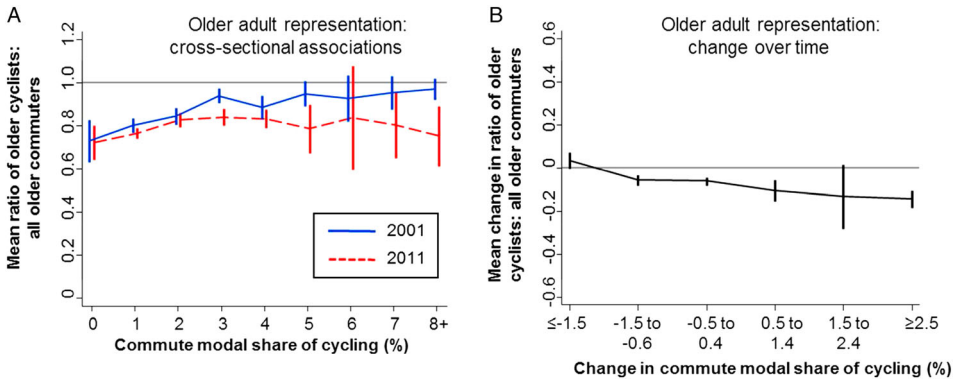
( $p < .001$  in both 2001 and 2011). Moreover, the nature of this effect was very similar between the two time points ( $p = .11$  for interaction between year and commute modal share — i.e. no significant difference between the two lines shown in Figure 3(A)). Cambridge is the UK local authority area that has long had the highest modal share for cycling: 28.3% in 2001 and 32.5% in 2011. In both years men and women were almost equally likely to cycle (gender ratio 0.994 in 2001 and 0.978 in 2011).

Somewhat surprisingly, given these cross-sectional results the longitudinal results showed that an increase in cycle modal share was not associated with any average increase in the representation of females among cyclists (Figure 3(B)). Moreover, although a decrease in cycle modal share was associated with a decrease in the representation of females, this decrease was less than half of what would have been expected given the cross-sectional association. Specifically, in the cross-sectional analyses a 1-percentage-point difference between local authorities in cycle modal share corresponded to an average change of 0.071 (95% CI 0.065, 0.077) in the female representation ratio. By contrast, a 1-percentage-point decrease over time corresponded to an average change to the ratio of female cyclists of only 0.029 (95% CI 0.021, 0.037).

Thus the effect of change in cycle modal share over time was only partly consistent with the cross-sectional picture: an effect in the expected direction was observed but only with respect to areas where the prevalence of cycling decreased, and the size of the effect was much smaller than would have been expected based on the cross-sectional data.

### Results for Older Adults

For England and Wales as a whole, the representation of older people among cycle commuters declined at the national level, changing from 0.84 in 2001 to 0.77 in 2011 (Figure 2(B)). The mean representation of older cyclists, however, remained higher than the representation of female cyclists. For example, there were no local authorities with a ratio  $< 0.4$  in 2011, and a small number in which older cyclists were in fact over-represented among cyclists ( $N = 27/346$  with a ratio  $\geq 1.0$  in 2011).



**Figure 4.** Representation of older adults among cyclists across 346 local authorities in England and Wales, cross-sectionally and over time.

Cross-sectionally, there was strong evidence that the modal share of cycling was associated with variation in the representation of older adults among cyclists ( $p < .001$  in 2001, and  $p = .006$  in 2011, 4A). The nature of this association, however, differed between 2001 and 2011 ( $p = .003$  for interaction). Specifically, in 2001 increasing modal share was associated with a progressive increase in the representation of older adults across the full range. By contrast, in 2011 this was true at very low cycling prevalence but the line then flattened and possibly even decreased again. It was also noticeable that even in 2001 the strength of this association between representation and modal share was much weaker for older adults than for females.

Longitudinally, areas that increased their modal share of adults saw a decrease in representation of older adults, while the reverse was true in areas that decreased their modal share (Figure 4(B)). Therefore no consistency was observed with the cross-sectional picture: instead, the two sets of analyses showed qualitatively opposite trends.

### Results for Inner London

Finally, we explored results for the 13 Inner London local authorities<sup>4</sup> (combining City with Westminster). All 13 authorities experienced an increase in cycle commuting rates between 2001 and 2011, with an overall increase from 3.8% to 7.2% cycle modal share.

Although we did not perform statistical tests because of the small sample size, the pattern of results for Inner London mirrored the national trends described above. Specifically, there was overall relatively little change in female representation of cyclists among the Inner London local authorities: eight saw an increase (sometimes very small), five a decrease and overall the ratio of cyclists who were female relative to all commuters was almost identical (0.645 in 2001, 0.648 in 2011). All Inner London local authorities saw a decrease in the proportion of older commuters, with an overall decrease of the ratio of older commuters from 0.75 in 2001 to 0.57 in 2011 (or from 14.9% of cyclists to 9.3% in absolute percentage terms). Thus in Inner London as in England and Wales as a whole, an increased cycle modal share did not translate into any change in the representation of female cyclists, and was associated with a decrease in the representation of older cyclists.

## Discussion

Our findings show that in those places where cycling to work has increased in England and Wales, there has been no statistically significant improvement in the representation of women among cycle commuters. Cycle commuting continues to be highly gender unequal and does not show the trend towards the greater equality that one would expect based on cross-sectional comparisons within the UK (e.g. with Cambridge) or internationally (e.g. with Germany, Denmark, and the Netherlands). Moreover, there has been a decline in age equity in those places where cycle commuting has increased. These findings are counter-intuitive, given cross-sectional data from the UK and other countries. In this final section, we acknowledge limitations of our research and make suggestions for further research, suggest reasons for the results, and highlight why these results are important for policy-makers.

### *Study Limitations*

In interpreting these findings, it is important to bear in mind that the Census is limited in including no information on non-commuter cycling. The analysis of National Travel Survey data from 2010 to 2012 suggests that the relative representation of females among cyclists is similar across commute and non-commute trips (ratio 0.55 for commute trips, ratio 0.61 for non-commute trips), but that the representation of older people among cyclists is higher for non-commute trips (ratio 0.80 for commute trips, 0.97 for non-commute trips) (DfT, 2013). Our focus is commuting trips; however, it would also be interesting to explore how the representation of females/older adults in non-commute cycling has been affected by changes in overall cycling levels in different areas. To our knowledge, no existing data-sets would be suitable for answering this question, but this would be an interesting line of research should such data become available in the future.

Drawing conclusions from the trends we have identified is challenging due to a lack of other relevant data. Britain has relatively poorly developed measures and data-sets relating to cycle infrastructure. In particular, we lack a comprehensive national database that could allow us to compare amounts of high-quality infrastructure, network connectivity, and so on between authorities. This in itself is a legacy of policy marginalisation (Aldred, 2012), but means that our interpretation of the findings is somewhat speculative and could be contested.

### *Interpretation of Findings*

In Dublin, as cycling declined, it became less gender-equal (Garrard et al., 2012). Our work similarly finds a statistically significant association between a fall in cycling and a fall in cycling gender equity in England and Welsh local authorities. Those authorities where cycling has fallen tend to be less affluent areas with a long-standing history of utility cycling, but where cycling remains culturally marginalised and associated with poverty (see Aldred & Jungnickel, 2014 on Hull). Continuing under-investment in cycling (characteristic of the UK generally) may have reinforced this marginalisation, and its impacts on gender equity.

In contrast, in English and Welsh local authorities where cycle commuting has grown, we found no evidence of a reduction in the gender gap. In the USA, Pucher, Buehler, and Seinen (2011) found an even bleaker picture; gender

imbalance *increasing* with a growth in cycling. Bicycle mode share for all trips remained static for women between 2001 and 2009, while it increased for men (Pucher et al., 2011, pp. 454–455). Exploring potential reasons for this further, Camp (2013) found that US cities that had increased the amount of bicycle infrastructure had seen a statistically significant increase in levels of cycle commuting among women, but that this relationship was not observed among men.

As cycling increases, cultural norms may take time to change and hold back changes in gender equity. For example, while a more ‘female-friendly’ cycling environment (e.g. in terms of more protected infrastructure, or a greater normalisation of cycling) could attract some women as ‘early adopters’, others may take longer to consider cycling, perhaps being prompted to try it after hearing about it from female colleagues or friends. However, one might still expect some statistically significant change, even if — as with the relationship between a fall in cycling and a fall in gender equity — not as large as we might expect from the cross-sectional associations.

The *decline* in age equity in areas where cycling is rising is similar in nature to Pucher et al.’s (2011) US findings with respect to gender. Again, one would expect some countervailing factors to reduce any positive gain in equity. As with gender, one might expect some time lag in the uptake of cycling by older people if most ‘early adopters’ tend to be younger. Indeed, there might even be cohort effects if those who cycle at older ages generally start cycling in young adulthood; this would imply that a substantial increase in cycling at older ages will not be seen until today’s young cyclists get older. However, to see a decline in age equity is concerning, as is the lack of any trend towards gender equity.

### *Implications for Policy*

The implication from these patterns is that policy *does* need to more explicitly consider the needs and preferences of under-represented groups. We cannot assume that growing cycling levels (characteristic of many dense urban areas) will automatically increase the gender and age diversity of cyclists. It might be helpful to think in terms of a differential threshold effect: that all else being equal, we need a more supportive cycling environment for women and older people to start cycling, on average, than we do for men and younger people. A differential threshold may exist for a range of reasons, including differences in trip characteristics or risk tolerance. The cycling environment would comprise a range of factors, but given the prominence of safety concerns among cited barriers to cycling, good-quality routes and infrastructure must be high on the list.

Hence, planners and policy-makers should study and respond to the infrastructural preferences of women, older people, and other under-represented groups. They should also examine how prevailing images and stereotypes of cycling may affect under-represented groups. Characteristically, the cover of the UK national cycle infrastructure design guide (DfT, 2008) shows a young man on a fast bicycle, with sporty clothing and a helmet. The proximity to motor traffic also pictured there forms part of a broader ‘vehicular cycling’ approach (cyclists as ‘vehicles’, integrated with rather than segregated from motor traffic) which has traditionally shaped UK cycling policy (Aldred, 2012). Pucher and Buehler (2009) argue that this approach has proved particularly unattractive to women, older people, and those who are less physically able. Given our findings, this critique should be taken seriously. The need to plan for greater diversity gains

additional salience given substantial gender (and other) inequalities within the transport sector (Wright, 2011).

Further study could helpfully tease out pathways into and out of cycling at different points in people's lives, for example, through longitudinal research. We need more research on the details of cycling environments necessary to enable a more diverse group of people to cycle, both in terms of 'objective' factors (such as cargo bicycle or tricycle width and handling) and 'subjective' factors (such as preferences for different route and infrastructure types). It has often been assumed in low-cycling countries that older and disabled people are incapable of cycling, despite evidence to the contrary from higher cycling contexts, and this has led to a neglect of these groups' needs in research. Although more research is needed, it is important not to wait for this, and we can still act to ensure that the preferences and needs of under-represented groups are foregrounded in policy and planning.

Finally, we would note that in recent years there has been an ongoing shift towards our recommended approach among the UK's leading cycling cities. Policy-makers have increasingly come to stress the importance of *not* building for the stereotypical MAMIL<sup>5</sup>, but for those who currently do not cycle (e.g. GLA, 2013). Similarly, cities such as Bristol and London have shifted to advertise cycling in more diverse ways, with less sporty images and a wider mix of people portrayed as riding. Future work should monitor the impacts of these strategies on uptake and diversity.

## Acknowledgements

J. W. also holds an MRC Population Health Scientist Fellowship and MRC Centenary Award. A. G. contributed to this research while funded by a postdoctoral fellowship from the National Institute for Health Research (NIHR). The views in this paper are those of the study authors, and do not necessarily reflect those of the Economic and Social Research Council (ESRC), NIHR, the NHS, or the Department for Health.

## Disclosure Statement

R. A. is an Elected Trustee of the London Cycling Campaign and Chair of its Elected Policy Forum. There are no other conflicts of interest.

## Funding

R. A. and J. W. were funded by the ESRC for the Changing Commutes project [ES/K004549/1].

## Notes

1. An interesting report, which otherwise demonstrates very high potential for cycling among Londoners.
2. Of course, some of the 72% may not be capable of riding a bicycle all the way to work: in the Netherlands there has been a recent boom in pedelecs (e-bikes), to enable this group to continue riding.
3. These were the City of London which was combined with Westminster as one merged Local Authority District, and the Isles of Scilly which was combined with Cornwall.
4. Using the Office for National Statistics definition of 'Inner London'
5. Middle-Aged Man in Lycra.

## References

- Aldred, R. (2012). Governing transport from welfare state to hollow state: The case of cycling in the UK. *Transport Policy*, 23, 95–102.
- Aldred, R. (2013). Incompetent or too competent? Negotiating everyday cycling identities in a motor dominated society. *Mobilities*, 8(2), 252–271.
- Aldred, R., & Jungnickel, K. (2014). Why culture matters for transport policy: The case of cycling in the UK. *Journal of Transport Geography*, 34, 78–87.
- Armstrong, T. (2013, June 25). Letter to the London evening standard by then living streets CEO Tony Armstrong.
- Beecham, R., & Wood, J. (2014). Exploring gendered cycling behaviours within a large-scale behavioural data-set. *Transportation Planning and Technology*, 37(1), 83–97.
- Bernhoft, I. M., & Carstensen, G. (2008). Preferences and behaviour of pedestrians and cyclists by age and gender. *Transportation Research Part F: Traffic Psychology and Behaviour*, 11(2), 83–95.
- Björklund, G., & Isacsson, G. (2013). *Forecasting the impact of infrastructure on Swedish commuters' cycling behaviour* (CTS Working Paper 2013: 36). Stockholm Centre for Transport Studies.
- Broach, J., Dill, J., & Gliebe, J. (2012). Where do cyclists ride? A route choice model developed with revealed preference GPS data. *Transportation Research Part A*, 46, 1730–1740.
- Buehler, R., Pucher, J., Merom, D., & Bauman, A. (2011). Active travel in Germany and the U.S.: Contributions of daily walking and cycling to physical activity. *American Journal of Preventive Medicine*, 41(3), 241–250.
- Butcher, L. (2012). Cycling: Policy. House of Commons Standard Note SN1097. Retrieved from [www.parliament.uk/briefing-papers/SN01097.pdf](http://www.parliament.uk/briefing-papers/SN01097.pdf)
- Camp, A. (2013). *Closing the bicycling gender gap: The relationship between gender and bicycling infrastructure in the nation's largest cities*. Project presented to the University of Oregon in partial fulfilment of the requirements for the degree of Master of Community and Regional Planning. Retrieved from [https://scholarsbank.uoregon.edu/xmlui/bitstream/handle/1794/12935/Camp\\_Terminal\\_Project\\_CRP\\_4%2026.pdf?sequence=1](https://scholarsbank.uoregon.edu/xmlui/bitstream/handle/1794/12935/Camp_Terminal_Project_CRP_4%2026.pdf?sequence=1)
- Caulfield, B., Brick, E., & McCarthy, O. T. (2012). Determining bicycle infrastructure preferences — a case study of Dublin. *Transportation Research Part D: Transport and Environment*, 17(5), 413–417.
- Clark, B., Chatterjee, K., Melia, S., Knies, G., & Laurie, H. (2014, January 6–8). Examining the relationship between life transitions and travel behaviour change: New insights from the UK household longitudinal study. In: *46th Universities' Transport Studies Group Conference*, Newcastle University.
- Department for Transport. (2008). *Cycle infrastructure design: LTN 2/08*. London: Author. Retrieved from <https://www.gov.uk/government/publications/cycle-infrastructure-design-ltn-208>
- Department for Transport. (2011; updated 2013). Delivering inclusive cycle training: A good practice guide for disability cycle training. Retrieved from [http://bikeability.dft.gov.uk/wp-content/uploads/130424\\_DisabilityTrainingGuide\\_Updated.pdf](http://bikeability.dft.gov.uk/wp-content/uploads/130424_DisabilityTrainingGuide_Updated.pdf)
- Department for Transport. (2013). National Travel Survey, 2002–2012, dataset deposited at the UK Data Archive (10.5255/UKDA-SN-5340-4).
- Dickinson, J. E., Kingham, S., Copsey, S., & Pearlman, D. J. (2003). Employer travel plans, cycling and gender: Will travel plan measures improve the outlook for cycling to work in the UK? *Transportation Research Part D: Transport and Environment*, 8(1), 53–67.
- Garrard, J., Handy, S., & Dill, J. (2012). Women and cycling. In J. Pucher & R. Buehler (Eds.), *City cycling* (pp. 211–234). Massachusetts: MIT Press.
- Garrard, J., Rose, G., & Lo, S. K. (2008). Promoting transportation cycling for women: The role of bicycle infrastructure. *Preventive Medicine*, 46(1), 55–59.
- Goodman, A. (2013). Walking, cycling and driving to work in the English and Welsh 2011 census: Trends, socio-economic patterning and relevance to travel behaviour in general. *PLOS ONE*, 8(8), e71790.
- Greater London Authority. (2013). The Mayor's vision for cycling in London. Retrieved from <http://www.london.gov.uk/sites/default/files/Cycling%20Vision%20GLA%20template%20FINAL.pdf>
- Handy, S., van Wee, B., & Kroesen, M. (2014). Promoting cycling for transport: Research needs and challenges. *Transport Reviews: A Transnational Transdisciplinary Journal*, 34(1), 4–24.
- Harms, L., Bertolini, L., & te Brömmelstroet, M. (2014). Spatial and social variations in cycling patterns in a mature cycling country: Exploring differences and trends. *Journal of Transport and Health*, 1(4), 232–242.
- Heesch, K. C., Sahlqvist, S., & Garrard, J. (2012). Gender differences in recreational and transport cycling: A cross-sectional mixed-methods comparison of cycling patterns, motivators, and con-



- straints. *International Journal of Behavioral Nutrition and Physical Activity*, 9, 106. Retrieved from <http://www.ijbnpa.org/content/9/1/106>
- Heinen, E., & Handy, S. (2012). Similarities in attitudes and norms and the effect on bicycle commuting: Evidence from the bicycle cities Davis and Delft. *International Journal of Sustainable Transportation*, 6(5), 257–281.
- Heinen, E., Maat, K., & van Wee, B. (2013). The effect of work-related factors on the bicycle commute mode choice in the Netherlands. *Transportation*, 40, 23–43.
- Heinen, E., van Wee, B., & Maat, K. (2010). Commuting by bicycle: An overview of the literature. *Transport Reviews: A Transnational Transdisciplinary Journal*, 30(1), 59–96.
- Horton, D. (2007). Fear of cycling. In P. Rosen, P. Cox, & D. Horton (Eds.), *Cycling and society* (pp. 133–152). Aldershot: Ashgate.
- Krizek, K. J., Johnson, P. J., & Tilahun, N. (2006). *Gender differences in bicycling behavior and facility preferences*. In Research on women's issues in transportation, report of a conference (pp. 31–40). Transportation Research Board.
- Office for National Statistics. (2012). 2011 Census: Local authority response and return rates. Retrieved June 27, 2013, from <http://www.ons.gov.uk/ons/guide-method/census/2011/census-data/2011-census-data/2011-first-release/first-release-quality-assurance-and-methodology-papers/census-response-rates.xls>
- Office for National Statistics. (2014). *2011 Census Analysis — Cycling to Work*. London: Author.
- Parliamentary Office for Science and Technology. (2013). *Peak car use in Britain, a briefing for the Commons Transport Select Committee*. Retrieved from <http://www.parliament.uk/documents/commons-committees/transport/POST-briefing-on-peak-car.pdf>
- Pooley, C., & Turnbull, J. (2000). Modal choice and modal change: The journey to work in Britain since 1890. *Journal of Transport Geography*, 8, 11–24.
- Pucher, J., & Buehler, R. (2008). Making cycling irresistible: Lessons from the Netherlands, Denmark and Germany. *Transport Reviews: A Transnational Transdisciplinary Journal*, 28(4), 495–528.
- Pucher, J., & Buehler, R. (2009). Cycling for a few or for everyone: The importance of social justice in cycling policy. *World Transport Policy and Practice*, 15(1), 57–64.
- Pucher, J., Buehler, R., & Seinen, M. (2011). Bicycling renaissance in North America? An update and re-appraisal of cycling trends and policies. *Transportation Research Part A: Policy and Practice*, 45(6), 451–475.
- Rietveld, P., & Daniel, V. (2004). Determinants of bicycle use: Do municipal policies matter? *Transportation Research Part A: Policy and Practice*, 38(7), 531–550.
- Rissel, C., Bonfiglioli, C., Emilsen, E., & Smith, B. J. (2010). Representations of cycling in metropolitan newspapers — changes over time and differences between Sydney and Melbourne, Australia. *BMC Public Health*, 10, 371. doi:10.1186/1471-2458-10-371
- Rogers, E. (1995). *Diffusion of innovations*. New York, NY: The Free Press.
- Sport England/Department for Transport. (2014). *Local area walking and cycling statistics: England 2012/13*. Retrieved from [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/306778/walking-and-cycling-statistics-release.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/306778/walking-and-cycling-statistics-release.pdf)
- Steinbach, R., Green, J., Datta, J., & Edwards, P. (2011). Cycling and the city: A case study of how gendered, ethnic and class identities can shape healthy transport choices. *Social Science & Medicine*, 72(7), 1123–1130.
- Transport for London. (2010). Analysis of cycling potential. Retrieved from <https://www.tfl.gov.uk/cdn/static/cms/documents/analysis-of-cycling-potential.pdf.pdf>
- Transport for London. (2012a). *Attitudes towards cycling*. London: Author.
- Transport for London. (2012b). *Cycle route choice final survey and model report*. London: Author.
- Twaddle, H., Hall, F., & Bracic, B. (2010). Latent bicycle commuting demand and effects of gender on commuter cycling and accident rates. *Transportation Research Record: Journal of the Transportation Research Board*, 2190, 28–36.
- Wang, J. Y. T., Mirza, L., Cheung, A. K. L., & Moradi, S. (2012). *Transforming Auckland into a bicycle-friendly city: Understanding factors influencing choices of cyclists and potential cyclists*. Paper presented to the Australasian Transport Research Forum, Perth.
- Winters, M., & Teschke, K. (2010). Route preferences among adults in the near market for bicycling: Findings of the cycling in cities study. *American Journal of Health Promotion*, 25(1), 40–47.
- Witlox, F., & Tindemans, H. (2004). Evaluating bicycle-car transport mode competitiveness in an urban environment: An activity-based approach. *World Transport Policy and Practice*, 10(4), 32–42.

- Woodcock, J., Givoni, M., & Morgan, A. S. (2013). Health impact modelling of active travel visions for England and Wales using an integrated transport and health impact modelling tool (ITHIM). *PLOS ONE*, 8(1), e51462.
- Woodcock, J., Tainio, M., Cheshire, J., O'Brien, O., & Goodman, A. (2014). Health effects of the London bicycle sharing system: Health impact modelling study. *BMJ: British Medical Journal*, 348:g425. Retrieved from <http://dx.doi.org/10.1136/bmj.g425>
- Wright, T. (2011). A 'lesbian advantage'? : Analysing the intersections of gender, sexuality and class in male-dominated work. *Equality, Diversity and Inclusion: An International Journal*, 30(8), 686–701.