

BENEFITS OF INVESTING IN CYCLING

Dr Rachel Aldred



In association with
Leigh Day

Investing in cycling; in numbers

Danish levels of cycling in the UK would **save the NHS**

£17 billion
within 20 years



... and **increase mobility** of the nation's **poorest families by 25%**

Cycling saves a **third of road space** compared to driving, to help **cut congestion**



More cycling and other sustainable transport could **reduce road deaths by 30%**



Bike lanes can **increase retail sales by a quarter**



Bike parking takes up **8 times less space** than cars, helping to free up space



Shifting just 10% of journeys from car to bike would reduce **air pollution** and save **400 productive life years**



Adopting **Dutch safety standards** could reduce **cycling casualties by two thirds**



This report was commissioned by British Cycling and made possible through support from law firm, Leigh Day

Executive summary

Dr. Rachel Aldred, Senior Lecturer in Transport, Faculty of Architecture and the Built Environment, University of Westminster

Investing in cycling will generate benefits for the whole country, not just those using a bike to get around. Eleven benefits are summarised here which can help solve a series of health, social and economic problems. This report shows how investing in cycling is good for our transport systems as a whole, for local economies, for social inclusion, and for public health.

Creating a cycling revolution in the UK requires sustained investment. In European countries with high cycling levels, levels of investment are also substantially higher than in the UK. The All-Party Parliamentary Cycling Inquiry has recommended a minimum of £10 annually per person, rising to £20, which would begin to approach the spending levels seen in high-cycling countries.

Investing in cycling will enable transport authorities to start putting in place the infrastructure we need to ensure people of all ages and abilities can choose to cycle for short everyday trips. As well as making cycle journeys more pleasant, safer and faster, it sends the signal that cycling is a normal way to travel. This is important because the perception of cycling as a marginal and minority mode is off-putting to many people.

This report was commissioned by British Cycling and made possible through support from law firm, Leigh Day.

How more cycling can transform the country

Getting more people on bikes would help to tackle numerous societal issues and the benefits would be felt by everyone – even if they do not cycle.

Problems	Benefits
Our inactive population means more people dying of conditions such as heart disease	More cycling means more people get the exercise they need, making for a healthier population
Motor traffic is a major cause of urban air and noise pollution	Cycle trips, unlike trips in motorised vehicles, don't generate air or noise pollution
Each year over 20,000 people are killed or seriously injured on Britain's roads	More cycling can make the streets safer for everyone
Our roads are riskier for people cycling than they need to be	Investing in cycling will mean cycling is safer and feels safer
Transport is a source of stress, particularly on the daily commute	Cycling can improve psychological well-being
People living on low incomes struggle to access jobs and services	Cycling can transform the mobility and life chances of Britain's poorest
Many children and older people suffer from a lack of independent mobility	Cycling promotes independence in youth and in older age
Many cities are dominated by through motor traffic and so aren't pleasant to spend time in	Designing well for cycling helps create more liveable, pleasant cities
Town centres are under pressure with over one in eight shops vacant across the country	Investing in cycling can boost local economic activity
Not only are many peak hour journeys slow, they are often unpredictably so	Cycling means more predictable journey times for people and goods in congested cities
Our transport systems are inefficient, wasting space and energy	Planning well for cycling enables a more efficient use of the transport network

More cycling means more people can get the exercise they need, making a healthier population

If people in urban England and Wales cycled and walked as much as people do in Copenhagen, the NHS could save around £17 billion within twenty years.

When the 2008 Health Survey for England measured physical activity objectively, rather than just asking people, only one in 20 adults achieved the minimum recommended 150 weekly minutes of at least moderate intensity exercise¹. This is making us sick, and costing us money.

Many scientific studies have found that regular physical activity reduces the risk of major killers including heart disease, stroke, breast cancer, colon cancer, and the growing problems of diabetes and dementia². This includes studies which specifically found cyclists on average lived longer than non-cyclists³.

Cycling is a good form of physical activity. Regular utility cycling, such as riding to work, builds exercise into busy everyday life. Cycling for 30 minutes each way to and from work is enough to achieve the higher recommended target of 300 minutes per week.

In London, the extra physical activity provided by more cycling and walking could prevent thousands of premature deaths every year⁴. There are also potentially big health care savings. If people in urban England and Wales cycled and walked as much as people in Copenhagen, the NHS could save around £17 billion within twenty years⁵.

Changes to the built environment are key to increasing population physical activity⁶. A study evaluating new motor-traffic free walking and cycling routes⁷ shows that after two years people living nearer the routes are getting more physical activity. The National Institute of Health and Care Excellence⁸ recommends giving those using active travel modes the highest priority when developing or maintaining streets and roads.

4 Woodcock et al 2009

5 Jarrett et al 2012

6 WHO 2009

7 Goodman et al 2014

8 NICE 2008

1 HSCIC 2014

2 Warburton 2010

3 Anderson et al 2000, Matthews et al 2007

Cycle trips, unlike motorised vehicles trips, don't generate air or noise pollution

Shifting 10% of short urban trips outside London from car to cycle could save over 100 premature deaths from air pollution related illnesses annually.

Before the 1956 Clean Air Act, coal fires were a major cause of urban air pollution, peaking in London's 1952 Great Smog, now estimated to have killed 12,000¹. Our coal stoves have virtually gone. Now transport is the overwhelming source of urban air and noise pollution².

Urban air pollution is associated with deaths from heart disease and lung cancer³. It has been estimated to kill 1.3 million a year globally⁴. Noise pollution is damaging too. A Canadian study found people in the noisiest 10% of areas experienced 22% more deaths from heart disease than those in the quietest 10% of areas⁵.

Moving motorised trips to cycling can improve the health of local people by cutting air pollution⁶. Shifting 10% of short urban trips from car to cycle, in English and Welsh urban areas outside London, could save over 100 premature deaths annually⁷.

1 Davies et al 2002

2 Vlachokostas et al 2012

3 de Hartog et al 2010

4 Haines and Dora 2012

5 Gan et al 2012

6 Lindsay et al 2011

7 Woodcock 2014

This could particularly benefit child health, because the most polluted areas are those where families with young children live⁸.

Being physically active in a polluted environment means breathing in more pollution. However, for an individual, the air pollution impact of shifting from car to cycle is quite small⁹ and depends on the environment¹⁰. Routes separating cyclists from motorised traffic help¹¹. A US study found that installing a cycle track protected by car parking reduced cyclists' exposure to ultrafine particulate matter, compared with an on-road cycle lane¹². Such infrastructure may also benefit pedestrians as distance from motor traffic is associated with lower pollution exposure¹³.

8 Mitchell and Dorling 2003

9 Woodcock et al 2014

10 Rabi and de Nazelle 2012

11 Jarjour et al 2013

12 Kendrick et al 2011

13 Kaur et al 2005

More cycling can make the streets safer for everyone

A more sustainable and active transport system could halve deaths and serious injuries on the roads.

More cycling can make everyone safer. When Woodcock et al¹ modelled the effects of three urban scenarios involving more cycling and walking, they found an overall *reduction* in injuries.

Mode shift from car trips to cycling or walking has two contradictory effects on injury. Firstly, an individual who switches from car to cycling or walking may see some increase in their own injury risk². But by no longer using a motor vehicle, they are posing less threat to others³. While some injury modelling approaches only consider the first point, Woodcock et al's model includes both.

With a big enough shift away from car trips, the societal trade-off becomes positive and we start to see reductions in overall road deaths and injuries. Woodcock et al found this in all their scenarios, but especially in the two where change was more substantial, with greater reductions in car trips and total travel distances.

1 Woodcock et al 2013

2 depending on age and gender: Mindell et al 2012

3 Bhalla et al 2007

For these two scenarios, deaths and serious injuries on the roads approximately halved, meaning over 500 premature deaths avoided each year (in urban England and Wales outside London). These findings make an important point. When people stop driving and start cycling (or walking, or using public transport) this provides a safety benefit for society as a whole.

While motor vehicles are the major threat, bicycles do cause some pedestrian injuries. However, encouraging evidence from New York and California, where cycling is growing, shows this already low figure falling further⁴. One reason could be that where cycle infrastructure is improved, cyclists are less likely to ride on the pavement and come into conflict with pedestrians⁵.

4 Tuckel et al 2014

5 NITC 2014



Investing in cycling will mean cycling is safer and feels safer

If cycling was as safe in the UK as in The Netherlands we would see around 80 fewer cycle deaths each year.

Many are put off cycling because of safety fears¹, but in the UK, most cycle deaths and serious injuries are not caused by cycling itself, but by motor vehicles. These risks can be massively reduced. Countries that have invested in cycling have low injury risks, despite few cyclists wearing safety equipment². In The Netherlands, adults under 30 experience a lower risk of dying, per kilometre when they cycle than when they drive³.

Per hour spent cycling, cyclists in England are around four times more likely to be killed than in The Netherlands⁴. In 2013 109 cyclists were killed in Britain⁵. If cycling were as safe as in The Netherlands, we would see around 80 fewer cycling deaths on the roads each year at current cycling levels. Put another way, we could have 12% rather than 3% of people commuting by bike, without any increase in cycling deaths.

A range of factors make cycling and walking more dangerous, including a lack of investment

in good quality infrastructure⁶. Macmillan et al⁷ compared different cycling investment scenarios in Auckland, New Zealand. They found that a limited investment would increase cycling injury risk, and more ambitious changes - specifically, physical segregation on arterial roads (with intersection treatments) and low speed, bicycle-friendly local streets - were needed to reduce risks and increase cycling uptake. A recent Canadian study found lower injury risks with bike-specific infrastructure along busy streets⁸.

Better quality infrastructure can both reduce risks and encourage more cycling. Objective injury risk matters, but people are also influenced by experiencing, seeing or hearing about hostile traffic conditions. This includes near misses, which unlike injury collisions are more likely to happen on link sections than junctions⁹. Studies show people feel safer on routes separating them from busy motor traffic, for example, involving separate infrastructure or quiet streets¹⁰.

1 TfL 2012

2 Pucher and Buehler 2008

3 de Hartog et al 2010

4 Mindell et al 2012

5 DfT 2014

6 Bhatia and Wier 2011

7 Macmillan et al 2014

8 Teschke et al 2012

9 Joshi et al 2001

10 Cauffield et al 2012, Björklund and Isacson 2013, Steer Davies Gleave 2012,

Wang et al 2012, Winters et al 2012, Winters and Teschke 2010

Cycling can improve psychological well-being

Many people who cycle say the emotional benefits are very important to them.

Travelling can be stressful, particularly on the daily commute¹. Traditionally, this has been accepted in transport economics, where time spent travelling is defined as lost time. However, increasingly academics argue that people can enjoy and value transport time².

We do not know enough about how cycling affects people's moods and emotions³. There seems to be much potential for cycling to increase well-being, with some studies finding a positive impact on well-being associated with cycling or walking to work⁴. A study of longer-distance Copenhagen cycle commuters found cycling helped with stress relief and transitions between work and home⁵.

Martin et al's⁶ longitudinal study found that switching from car commuting to active travel (walking or cycling) improves psychological well-being. For example, car commuters were at least 13% more likely to report being constantly under strain or unable to concentrate, compared to those using active travel. Because cycling is a form of moderate to vigorous physical activity it may help in treatment of mental illnesses such as depression⁷ and help prevent depression in the first place⁸.

Current cyclists value the emotional benefits of cycling⁹:

'We found that motivations for cycling were varied and included physical health benefits, cost and convenience, which have been cited in other research. [...] Additionally, emotional benefits of cycling were described as important by many interviewees, for example in terms of 'me time' and 'winding down'. The physical activity provided by cycling can simultaneously produce emotional health benefits, although the extent and nature of this will depend upon the cycling environment. [...]

"[Bristol to Bath] cycle track, although it's going into the middle of Bristol city, it feels like it's a country lane. You've got like allotments either side, you've got trees growing over. So, it's quite pretty. So, it just, it clears your mind a little bit. It just gives you a little bit of time to think, especially when you're coming back to a house full of kids"
Neil, Bristol.'

As emotional benefits from cycling can be counteracted by hostile traffic¹⁰, there is a need to provide relaxed and pleasant cycling environments. The presence of nature or green space enhances mood benefits from physical activity¹¹. Stefánsdóttir¹² found cycle commuters positively value aesthetic experience with greenery, contact with the natural environment and distance from motorised traffic being most important.

9 Aldred and Jungnickel 2012: 18

10 Bonham and Koth 2010

11 Barton and Pretty 2010, Mitchell 2013

12 Stefánsdóttir 2014

1 Guell et al 2012

2 Jains and Lyon 2008

3 Spinney 2013

4 Smith 2013

5 Hansen and Nielsen 2014

6 Martin et al 2014

7 NICE 2009

8 Woodcock et al 2009

Cycling can transform the mobility and life chances of Britain's poorest

Increasing cycling to Danish levels could increase the mobility of the poorest by a quarter.

The poorest groups suffer from lack of access to transport. Among the richest fifth of English households, half own two or more cars, with only one in seven living without a car. But in the poorest fifth of households, nearly half have no car¹.

Transport is a key barrier for people looking for work². The 2011 Census figures show jobseekers in England and Wales are three times more likely to live in a no-car household than employed people.

Many people on low incomes face either a struggle to get around without a car, with public transport expensive or limited, or a struggle to pay for their car³. Despite this, most do not see cycling as an option⁴.

Poor infrastructure is one reason. Studies have found that the kinds of attributes needed to 'be a cyclist' in hostile conditions may create additional barriers for under-represented groups⁵.

1 DfT 2014a

2 SEU 2003

3 Titheridge et al 2014

4 Pooley et al 2013

5 Aldred 2012, Aldred 2013, Steinbach et al 2011

Investing in cycling can address these physical and psychological barriers⁶, so enabling people in lower income households to access jobs and services and reducing their need to own and use cars.

Denmark shows how different things could be. Cycling there is a normal form of transport for all income groups, but most importantly for the mobility of the poorest. Danes in households with incomes below \$13,004 make 2.7 trips per day, of which 26% (0.7) are by bicycle⁷. By contrast people in the poorest fifth of English households (below £15,823) only make 2.2 trips per day⁸.

While trip rates in England by other modes are fairly similar to those by lower income Danes, the big difference is that cycling levels are much lower (0.03 trips per day, rather than 0.7). This suggests that if we can get people in the poorest income groups cycling at Danish levels, we could increase mobility by up to a quarter.

6 Steinbach et al 2011

7 Green Lane Project 2014

8 DfT 2014a



Cycling promotes independence in youth and at older ages

Provision for cycling could make a big difference to children's and older people's lives.

Within the European context, children in the UK experience low levels of independent mobility¹. Many older people do too, particularly when they can no longer drive. Stopping driving has negative impacts for older people, which also harms society, as it leads to reductions in paid work and informal volunteering².

In the UK, cycling is not seen as an option by most children and older people. Only 1% of 5-10 year-olds and 3% of 11-15 year-olds cycle to school. Many would like to walk or cycle, but are not allowed³. Cycling is virtually absent among over-65s - only 8% of men and 3% of women do any cycling ever in a month, compared to 20% and 10% for all ages⁴. Some studies suggest mixing with motor traffic is particularly off-putting for older adults⁵.

In high-cycling contexts, cycling means independence for young and old alike, with a range of related benefits. 49% of all Dutch primary school children ride to school⁶. Over 10% of all trips by Danish and German over-65s are by bicycle, as are 24% of all trips by Dutch over-65s⁷. Even among Dutch people aged 80-84, over 20% prefer their bicycle to any other transport mode⁸.

In the UK free bus services have had positive impacts on older people's well-being⁹ and investing in age-friendly cycle infrastructure could pay similar

dividends. Winters et al (2014) found that in an area of Vancouver with a relatively good cycling environment, a quarter of older adults (average age 70) surveyed cycled in a week, of whom over half were getting their recommended levels of physical activity just from cycling.

Health benefits of cycling are largest for those in older age groups¹⁰. In The Netherlands, high levels of cycling help older people get the exercise they need. In fact, over two-thirds of Dutch people aged 55-74 living independently say they reach the national standard of half an hour of moderately intensive physical activity on at least five days per week, significantly more than their counterparts in younger age groups (35-54)¹¹.

There is increasing evidence that physical activity helps reduce cognitive impairment and dementia risk¹². A recent Welsh study¹³ found that among five healthy behaviours, exercise in particular was an important predictor of cognitive impairment and dementia:

'Had the two and a half thousand men in CaPS [the Caerphilly study] each been urged at baseline to adopt one additional healthy behaviour [such as regular exercise], and if only half of them had complied, then during the following 30 years there would have been a 13% reduction in dementia, a 12% drop in diabetes, 6% less vascular disease and a 5% reduction in total mortality.'¹⁴

1 Shaw et al 2014

2 Curi et al 2014

3 Lorenc 2008

4 Sport England/ONS 2014

5 Zander et al 2013

6 (while another 37% walk: Fietsberaad 2009)

7 Pucher and Buehler 2008

8 Daniel et al 2013

9 Mackett 2014

10 Woodcock et al 2014

11 de Boer 2006

12 Ahlskog et al 2011

13 Elwood et al 2013

14 Elwood et al 2013

Designing well for cycling helps create more liveable, pleasant cities

Neighbourhoods that work for walking and cycling are friendlier places.

In the post-war period, many cities were redesigned around the automobile, often creating hostile and car-dominated urban streets. By contrast, city leaders in Copenhagen have for some time seen bike-friendliness as a key part of a more hospitable and 'hygge' (cosy) city¹.

While excessive motor traffic threatens the city, re-designing cities for cycling can have wider 'place' benefits². Greener urban environments are associated with better experiences of walking and cycling³. Routes for people on foot and on cycles that are completely away from motor traffic, like many on London's Greenway network, can both be popular for leisure and utility trips and pleasant places in themselves⁴.

Other interventions to boost cycling can also create better places. Making residential streets cycle-friendly, by cutting rat-running and calming motor traffic, can benefit cyclists, pedestrians, and residents⁵. Streets with little motor traffic are popular with cyclists and pedestrians, and encourage people to make friends with neighbours and spend time on their streets⁶. In Hart and Parkhurst's study, people living on a street without

through motor traffic knew and supported their neighbours to a much greater extent than people on two other streets with more typical and substantial levels of rat-running.

'Especially the elderly residents [on the street without through motor traffic] felt supported and cared for: a 70-year old woman who lived alone remarked that "people on the street have always helped each other in times of illness and difficulty". Another older lady living alone felt lucky to live on such a street where "everyone's kind, thoughtful, helpful, and really lovely to me. When my next door neighbour hasn't seen me for a few days, he knocks just to see if I'm okay".'⁷

In Vancouver, a study of new cycle tracks suggests they may have made pedestrians perceive the block as 'less polluted, less overcrowded, more stimulating, and more peaceful'⁸. A recent US study examined how seven new protected bicycle lanes affected local pedestrians. At all sites pedestrians tended to report fewer pavement cyclists, while at most sites, reported benefits included lower driving speeds, safer crossings, and better walking environments⁹.

1 Nielsen et al 2013

2 Forsyth and Krizek 2011

3 Snizek et al 2013

4 TiL 2013

5 Winters and Teschke 2010, Sinnott et al 2011

6 Hart and Parkhurst 2011

7 Hart and Parkhurst 2011: 17

8 Jay 2014: 97

9 NITC 2014

Investing in cycling can boost local economic activity

Installing protected space for cycling can increase retail sales by up to a quarter.

The economic downturn has hit town centres hard. Nationally, two in every 15 shops are standing vacant, with some regions and cities suffering much more¹. For example, in Swansea nearly one in four shops is vacant.

While providing more car parking is often touted as the solution, encouraging sustainable transport plays to the strengths of the local high street. Retailers over-estimate the contribution of drivers and many studies find users of sustainable modes spend more per month². Providing for cycling can be good for local business. Examples from North America show high-quality bicycle infrastructure does not harm business districts, and can have a positive impact on local shops³.

The NYCDot (2014) study found streets where protected cycle lanes were installed saw an increase in retail sales up to 24% greater than comparator sites without protected lanes. One reason for this could be that the cycle lanes improved pedestrian environments, with shorter crossing distances.

Cycling can help create the kinds of places people want to shop, as in Amsterdam's Utrechtsestraat, where thriving independent businesses happily coexist with streams of parents carrying children on cargo bicycles⁴. At a city-level, after the Hague implemented its Circulation Plan, reallocating space from through motor traffic to walking and cycling, changes in local economic indicators beat comparator cities⁵. By contrast higher levels of motor traffic have been associated with higher shop vacancy rates⁶.

Impact goes beyond retail: a national US study found that for each \$1 million, cycling infrastructure projects created 11.4 local (state) jobs compared to 7.8 jobs for road-only projects⁷. Just looking at cycling-related purchases and services, UK cyclists each contribute £230 yearly to the economy⁸.

4 Zukin 2012

5 Tiemens and Molenaar 2014

6 Sustrans 2003

7 Garrett-Peltier 2011

8 Grous 2011

1 Butler 2014

2 Clifton et al 2013

3 Arancibia 2013, NYCDot 2012, Rowe 2013, Sztabinski 2009

Cycling means more predictable journey times for people and goods in cities

Shifting urban trips from car to cycle makes for a more reliable transport system.

Peak hour congestion means slow and unreliable motorised journeys. Average speeds on local 'A' roads in England during the weekday morning peak are less than 25mph, falling to 16 mph in London¹. One in five journeys on 'strategic' Highways Agency roads are delayed².

Transport modelling and appraisal has traditionally prioritised saving journey time³. But having predictable journey times may actually be more important to people than saving time in itself⁴.

The importance of journey time reliability is another argument for investing in cycling, which is a relatively predictable mode. Traffic conditions affect the speeds of people cycling less than they affect the speeds of people driving⁵. Unsurprisingly journey time reliability is an important motivator for cycling⁶.

Journey time reliability is also a motivator for cities to invest in cycling. In London alone the annual economic cost of motorised vehicle delays is estimated at over £1.5 billion⁷. Because cycle journey times are relatively constant, shifting trips from car to cycle in congested cities can increase the reliability of the transport system.

Freight journey time reliability is also important, with late deliveries meaning negative impacts for carriers and customers⁸. Cargo cycles could replace up to a quarter of European urban freight trips⁹, with reliability and speed cited as advantages¹⁰.

'Vive la Rose [...] has used cycle freight carriers for two years now and is very positive about them. They find them quick, reliable and efficient.'¹¹

'Pocket Guides have found that the bicycle couriers are always very reliable and they have not experienced any problems.'¹²

'Normal car couriers give [PSC] a certain delivery time within three hours due to the traffic and parking etc. whereas the bicycle courier guarantees a one hour delivery. Deliveries by bicycle also work out cheaper than deliveries by car or motorbike. [...] PSC feel that bicycle courier is much more efficient and reliable than a motorised courier and would not consider switching back even if that option was cheaper.'¹³

'Limoncello have found that the cycle couriers have been very reliable and consider them to be generally more reliable than taxis.'¹⁴

'The bicycle couriers provide a personal service and are very reliable and consequently are preferred [by Fitzbillies bakery] to taxis or other types of couriers.'¹⁵

'The main advantage of bicycle deliveries is the punctuality as they are very reliable. It also works out cheaper than having a dedicated delivery driver. This pharmacy was unable to identify any negative aspects of using a bicycle courier.'¹⁶

As with personal journey times the reliability benefit depends on infrastructure: for example, whether cycles can legally use one-way streets in both directions.

1 DfT 2014b

2 DfT 2014c

3 Lyons and Urry 2004

4 Asensio and Matas 2008, Carrion and Levinson 2012

5 TfL 2009

6 Jones and Ogilvie 2012

7 TfL 2006

8 De Jong et al 2014

9 Lenz and Riehle 2013

10 TfL 2009a

11 TfL 2009: 27

12 TfL 2009: 28

13 TfL 2009: 28

14 TfL 2009: 29

15 TfL 2009: 30

16 TfL 2009: 31



Planning well for cycling enables a more efficient use of the transport network

Cycle trips are over three times, and cycle parking up to eight times, more space efficient than cars.

A transport system based around the private car is inefficient in space and energy terms. It threatens Britain's ability to meet its commitment to an 80% cut in Greenhouse Gas Emissions by 2050¹. Per person-kilometre, cycling is the mode with the lowest energy intensity². So increases in cycling can also make Britain's transport system more energy efficient.

In many of our cities there is also severe pressure on road space, and buses and cycles are the most space-efficient passenger transport modes³. Average car or van occupancy is 1.56, and with cycles valued as taking up 1/5 the space of a car, on average each cycle trip is over three times more space efficient per person than each car trip.

Providing for cycling can help authorities better allocate scarce capacity, managing congestion on public transport and on roads⁴. Cycling could reduce pressure on suburban corridors that link residential areas with rail stations. Only 3% of feeder trips to UK regional train services are cycled, compared to 30% in The Netherlands⁵.

Vehicles spend over 80% of their time parked⁶, so car parking also makes major demands on city space and resources⁷. Cycle parking is highly space-efficient, with one on-street car space able to accommodate up to 10-12 bicycles. Again dividing by average car or van occupancy, this means cycle parking is up to around eight times more space efficient per person trip.

Supporting cycling can help make the whole transport system more efficient. Seville's cycling revolution provides one example: while some cycle trips replaced bus trips, overall public transport's mode share grew, as some car commuters then shifted to buses⁸. Allocating space for cycling has benefited other users in New York's Central Business district, with car and taxi journey times stable or even decreasing⁹.

1 DECC 2014

2 Lovelace and Philips 2014

3 Balderson 2013

4 GLA 2013; van Goeverden and Godefrooij 2011

5 Martens 2004

6 Marsden 2006

7 Shoup 2011

8 Marqués et al 2012

9 (NYCDOT 2014)

Bibliography

Where a source is freely available online, the URL has been provided.

Ahlskog, J. E. et al 2011 Physical exercise as a preventive or disease-modifying treatment of dementia and brain aging. *Mayo Clinic Proceedings* 86(9):876-84 <http://po.st/UH8drT>

Aldred, R. 2010 'On the outside': constructing cycling citizenship *Social & Cultural Geography* 11(1): 35-52 <http://po.st/cmLoLG>

Aldred, R. 2012 Governing transport from welfare state to hollow state: The case of cycling in the UK *Transport Policy* 23: 95–102 <http://po.st/3R4RCX>

Aldred, R. 2013 Incompetent or too competent? Negotiating everyday cycling identities in a motor dominated society *Mobilities* 8 (2), 252-271 <http://po.st/2GIXZZ>

Aldred, R. and Jungnickel, K. 2012 Cycling Cultures: summary of key findings and recommendations <http://po.st/Xyc3JW>

Anderson, L.B., Schnohr, P., Schroll, M. and Hein, H.O. 2000 All-Cause Mortality Associated With Physical Activity During Leisure Time, Work, Sports, and Cycling to Work *Archives of Internal Medicine* 160(11): 1621-1628 <http://po.st/rqkTJc>

Anderson, M. 2014 How protected bike lanes helped Denmark win its war on inequality <http://po.st/Jh9OW2>

Arancibia, D. 2013 Cyclists, Bike Lanes, and On-Street Parking: Economic Impacts Toronto University of Toronto <http://po.st/r767TI>

Asensio, J. and Matas, A. 2008 Commuters' valuation of travel time variability *Transportation Research Part E* 44 (2008) 1074–1085 <http://po.st/L7PTpS>

Balderson, K. 2013 Does London Have Space for Taxis? MSc Dissertation. London: Westminster University

Barton, J. and Pretty, J. 2010 What is the Best Dose of Nature and Green Exercise for Improving Mental Health? A Multi-Study Analysis. *Environmental Science and Technology* 44 (10): 3947–3955 <http://po.st/Dv6mIQ>

Bhalla, K., Ezziati, M., Mahal, A., Salomon, J. and Reich M. 2007 A Risk-Based Method for Modeling Traffic Fatalities. *Risk Analysis: An International Journal* 27(1): 125-136.

Bhatia, R. and Wier, M. 2011 "Safety in Numbers" re-examined: Can we make valid or practical inferences from available evidence? *Accident Analysis & Prevention* 43(1) : 235–240

Björklund, G. and Isacson, G. 2013 Forecasting the impact of infrastructure on Swedish commuters' cycling behaviour Stockholm Centre for Transport Studies, KTH <http://po.st/1poWZ8>

Bonham, H. and Koth, B. 2010 Universities and the cycling culture *Transportation Research Part D* 15: 94–102

Butler, S. 2014 Shop vacancy rates fall in UK but regions vary wildly *theguardian.com*, Monday 10 February 2014 <http://po.st/a0erMP>

Campaign for Better Transport 2011 Buses Matter: a report by Campaign for Better Transport for the RMT <http://po.st/hKESSc>

Campaign for Better Transport 2012 Transport and Poverty: A Literature Review <http://po.st/oOD7nn>

Caulfield, B., Brick, R. and McCarthy, T. 2012 Determining bicycle infrastructure preferences – A case study of Dublin *Transportation Research Part D: Transport and Environment* 17(5): 413–417 <http://po.st/EzHzu2>

Clifton, K.J., Muhs, C., Morrissey, S., Morrissey, T., Currans, K. and Ritter, C. 2013 Examining Consumer Behavior and Travel Choices <http://po.st/WaXtdP>

Curl, A.L., Stowe, J.D., Cooney, T.M. and Proulx, C.M. 2014 Giving Up the Keys: How Driving Cessation Affects Engagement in Later Life. *The Gerontologist* 54 (3): 423-433

Daniel, B., Pokriefke, E., Risser, R., Biler, S., Šenk, P., Parkes, A., Stannard, J., Armoogum, J., Lamellet, C.M., Gabaude, C., Madre, J.L., Alauzet, A., i Bort, H.M. and Henriksson, P. (2013) Mobility Patterns in the Ageing Populations <http://po.st/Lm32Tw>

Davies, D.L., Bell, M.L. and Fletcher, T. 2002 A Look Back at the London Smog of 1952 and the Half Century Since *Environmental Health Perspectives* 110(12): 734 <http://po.st/KK1T3Q>

de Boer, A.H., ed. (2006) Report on the Elderly, Social and Cultural Planning Office of the Netherlands <http://po.st/3JdzA>

de Hartog, J.J. et al 2010 Do the Health Benefits of Cycling Outweigh the Risks? *Environmental Health Perspectives* 118(8): 1109–1116 <http://po.st/8loQgJ>

de Jong, G., Kouwenhoven, M., Bates, J., Koster, P., Verhoef, E., Tavasszye, L. and Warffemius, P. 2014 New SP-values of time and reliability for freight transport in the Netherlands. *Transportation Research Part E: Logistics and Transportation Review*. 64: 71–87 <http://po.st/1Dwd8e>

Department for Transport 2012 Cycling to School: A review of school census and Bikeability delivery data <http://po.st/yaC2cv>

Department for Transport 2014 Reported Road Casualties in Great Britain: Main Results 2013 <http://po.st/wJLEMr>

Department for Transport 2014a National Travel Survey Tables <http://po.st/uYbTKg>

Department for Transport 2014b Congestion on Local A Roads in England: April to June 2014 <http://po.st/bT9zKb>

Department for Transport 2014c Reliability of journeys on Highways Agency Roads <http://po.st/IMG6jG>

Department of Energy and Climate Change 2014 Policy: Increasing the Use of Low-Carbon Technologies <http://po.st/s2USup>

Elwood, P., Pickering, J., Palmer, S., Bayer, A., Ben-Shlomo, Y., Longley, M. and Gallacher, J. 2013 Healthy Lifestyles Reduce the Incidence of Chronic Diseases and Dementia: Evidence from the Caerphilly Cohort Study. *PLoS ONE* 8(12): e81877 <http://po.st/0dyq4m>

Fietsberaad 2009 Cycling in the Netherlands <http://po.st/v9cTUL>

Forsyth, A. and Krizek, K. 2011 Urban Design: Is there a Distinctive View from the Bicycle? *Journal of Urban Design*, 16:4, 531-549 <http://po.st/6MawaE>

Gan, W.Q., Davies, H.W., Koehoorn, M. and Brauer, M. 2012 Association of Long-term Exposure to Community Noise and Traffic-related Air Pollution With Coronary Heart Disease Mortality. *American Journal of Epidemiology* 175(9): 898-906 <http://po.st/Vkqrha>

Garrett-Peltier, H. 2011 Pedestrian and Bicycle Infrastructure: a national study of employment impacts. Massachusetts University of Massachusetts <http://po.st/pcXHYf>

Goodman, A., Sahlqvist, S. and Ogilvie, D. 2014 New Walking and Cycling Routes and Increased Physical Activity: One- and 2-Year Findings From the UK iConnect Study. *American Journal of Public Health*: 104(9): e38-e46 <http://po.st/LNIQc5>

Greater London Authority 2013 The Mayor's Vision for Cycling: an Olympic Vision for all Londoners <http://po.st/Vzsfj7>

Greater London Authority 2014 Transport and Health in London: The main impacts of London road transport on health <http://po.st/OAHEQJ>

Grous, A. 2011 The British Cycling Economy. London: LSE <http://po.st/RDzNA6>

Guell, C., Panter, J., Jones, N.R. and Ogilvie, D. 2012 Towards a differentiated understanding of active travel behaviour: Using social theory to explore everyday commuting *Social Science & Medicine* 75: 233-239 <http://po.st/nzW8VA>

Haines, A. and Dora, C. 2012 How the low carbon economy can improve health *BMJ* 2012; 344 <http://po.st/8i9FA>

Hansen, K.B. and Nielsen, T.A.S. 2014 Exploring characteristics and motives of long distance commuter cyclists. *Transport Policy* 35: 57–63

Hart, J. and Parkhurst, G. 2011 Driven to excess: Impacts of motor vehicles on the quality of life of residents of three streets in Bristol, UK. *World Transport Policy & Practice* 17(2): 12-30 <http://po.st/LCp93L>

Health and Social Care Information Centre 2014 Statistics on Obesity, Physical Activity and Diet: England 2014 <http://po.st/GfZZI>

Jain, J. and Lyons, G. 2008 The Gift of Travel Time, *Journal of Transport Geography* 16 (2): 81–89 <http://po.st/5pik7C>

Jarjour, S., Jerrett, M., Westerdahl, D., de Nazelle, A., Hanning, C., Daly, L., Lipsitt, J. and Balme, J. 2013 Cyclist route choice, traffic-related air pollution, and lung function: a scripted exposure study. *Environmental Health* 12:14 <http://po.st/qvHEX>

Jarrett, J., Woodcock, J., Griffith, U.K., Chalabi, Z., Edwards, P., Roberts, I. and Haines, A. 2012 Effect of increasing active travel in urban England and Wales on costs to the National Health Service. *Lancet* 379, 9832: 2198–2205 <http://po.st/j20FC>

Jay, S. 2014 How are pedestrians in Vancouver being impacted by separated bike lanes? San Francisco SFU <http://po.st/1YU2sg>

Jones, C. and Ogilvie, D. 2012 Motivations for active commuting: a qualitative investigation of the period of home or work relocation *International Journal of Behavioral Nutrition and Physical Activity* 9: 109-120 <http://po.st/kQMIH2>

Joshi, M.S., Senior, V. and Smith, G.P. 2001 A diary study of the risk perceptions of road users *Health, Risk and Society*, 3:3, 261-279

Kaur, S., Nieuwenhuijsen, M.J. and Colville, R.N. 2005 Pedestrian exposure to air pollution along a major road in Central London, UK. *Atmospheric Environment* 39: 7307–7320

Kendrick, C.M., Moore, A., Haire, A., Bigazzi, A., Figliozzi, M., Monsere, C.M. and George, L. 2011 Impact of Bicycle Lane Characteristics on Exposure of Bicyclists to Traffic-Related Particulate Matter *Transportation Research Record*, No. 2247: 24–32 <http://po.st/vsEaeE>

Lenz, B. and Riehle, E. 2013 Bikes for Urban Freight? Experience for the European case. Paper Submitted for Presentation and Publication at TRB 92th Annual Meeting 2013 <http://po.st/fvd65Z>

Lindsay, G., Macmillan, A. and Woodward, A. 2011 Moving urban trips from cars to bicycles: impact on health and emissions. *Australian and New Zealand Journal of Public Health* 35(1): 54–60

Lorenc, T., Brunton, G., Oliver, S., Oliver, K. and Oakley, A. 2008 Attitudes to walking and cycling among children, young people and parents: a systematic review. *Journal of Epidemiology and Community Health* 62: 852-857 <http://po.st/3NgWch>

Lovelace, R. and Philips, I. 2014 The 'oil vulnerability' of commuter patterns: A case study from Yorkshire and the Humber, UK. *Geoforum* 51: 169–182 <http://po.st/3Spl3x>

Lyons, G. and Urry, J. 2004 Travel time use in the information age. *Transportation Research Part A* 39: 257–276 <http://po.st/HBAzEX>

Mackett, R. 2014 Has the policy of concessionary bus travel for older people in Britain been successful? *Case Studies on Transport Policy* 2 (2014) 81–88

Macmillan, A., Connor, J., Witten, K., Kearns, R., Rees, D. and Woodward, A. 2014 The Societal Costs and Benefits of Commuter Bicycling: Simulating the Effects of Specific Policies Using System Dynamics Modeling <http://po.st/77gQOt>

Marqués, R., Hernández, V., Calvo, M. and García-Cebrián, J.A. 2012 Sevilla: a successful experience of promotion of urban cycling in the south of Europe. Presentation to Velo-city Conference <http://po.st/jMmm8h>

Marsden, G. 2006 The evidence base for parking policies—a review *Transport Policy* 13 (2006) 447–457 <http://po.st/S7NCOW>

Martens, K. 2004 The bicycle as a feeding mode: experiences from three European countries. *Transportation Research Part D: Transport and Environment* 9(4) 281–294

Martin, A., Goryakin, Y. and Suhrcke, M. 2014 Does active commuting improve psychological wellbeing? Longitudinal evidence from eighteen waves of the British Household Panel Survey, *Preventive Medicine*, in press <http://po.st/adGSvs>

Matthews, C.E., Jurj, A.L., Shu, X., Li, H., Yang, G., Li, Q., Gao, Y. and Zheng, W. 2007 Influence of Exercise, Walking, Cycling, and Overall Nonexercise Physical Activity on Mortality in Chinese Women. *American Journal of Epidemiology* 165: 1343–1350 <http://po.st/vHrIMh>

Mindell, J.S., Leslie, D. and Wardlaw, M. 2012 Exposure-Based, 'Like-for-Like' Assessment of Road Safety by Travel Mode Using Routine Health Data. *PLoS ONE* <http://po.st/7rw0qa>

Mitchell, G. and Dorling, D. 2003 An environmental justice analysis of British air quality. *Environment and Planning A* 35: 909-929 <http://po.st/T4GtTR>

Mitchell, R. 2013 Is physical activity in natural environments better for mental health than physical activity in other environments? *Social Science & Medicine* Volume 91: 130–134

National Institute for Health and Care Excellence 2008 Physical activity and the environment <http://po.st/8DmYJE>

National Institute for Health and Care Excellence 2009 Depression in adults: The treatment and management of depression in adults <http://po.st/TkjpKF>

National Institute for Transportation and Communities 2014 Lessons from the Green Lanes: Evaluating Protected Bike Lanes in the U.S. <http://po.st/Vx8jB>

New York City Department of Transport 2012 Measuring the Street: New Metrics for 21st Century Streets <http://po.st/YFMW2H>

New York City Department of Transport 2014 Protected Bicycle Lane Analysis <http://po.st/e0ekWp>

Nielsen, T.A.S., Skov-Petersen, H. and Carstensen, T.A. 2013 Urban planning practices for bikeable cities – the case of Copenhagen *Urban Research & Practice*, 6:1, 110-115 <http://po.st/2Nx9J5>

Passenger Transport Executive Group 2010 The effect of bus fare increases on low income families <http://po.st/7AdCsi>

Pooley, C., Jones, T., Tight, M., Horton, D., Scheldeman, G., Mullen, C., Jopson, A and Strano, E. 2013 Promoting Walking and Cycling: new perspectives on sustainable travel Bristol Policy Press

Pooley, C., Tight, M., Jones, T., Horton, D., Scheldeman, G., Jopson, A., Mullen, C., Chisholm, A., Strano, E. and Constantine, S. 2011 Understanding Walking and Cycling: Summary of Key Findings and Recommendations <http://po.st/Tlo8Uy>

Pucher, J. and Buehler, R. 2008 Making Cycling Irresistible: Lessons from The Netherlands, Denmark and Germany. *Transport Reviews* 28(4): 495-528 <http://po.st/a4MeeZ>

Rabl, A. and de Nazelle, A. 2012 Benefits of shift from car to active transport. *Transport Policy* 19: 121–131 <http://po.st/PP49H8>

Rowe, K. 2013 BIKENOMICS: Measuring the Economic Impact of Bicycle Facilities on Neighborhood Business Districts. Washington, DC University of Washington <http://po.st/owK03H>

Schepers, J.P. and Heinen, E. 2012 How does a modal shift from short car trips to cycling affect road safety? *Accident Analysis and Prevention* 50: 1118–1127 <http://po.st/Yuw7y>

Shaw, B., Watson, B., Frauendienst, B., Redecker, A., Jones, T. with Hillman, M. 2012 Children's independent mobility: a comparative study in England and Germany (1971-2010) London: Policy Studies Institute <http://po.st/YdLlL>

Shoup, D. 2011 The High Cost of Free Parking (updated) Washington, D.C. American Planners' Association.

Sinnett, D., Williams, K., Chatterjee, K. and Cavill, N. 2011 Making the case for investment in the walking environment: A review of the evidence. London: Living Streets <http://po.st/kLW7Z>

Smith, O.B. 2013 Peak of the Day or the Daily Grind: Commuting and Subjective Well-Being Portland, Oregon University of Portland PhD Thesis. <http://po.st/SZ9hIb>

Snizek, B., Sick Nielsen, T.A. and Skov-Petersen, H. 2013 Mapping bicyclists' experiences in Copenhagen. *Journal of Transport Geography* 30: 227–233

Social Exclusion Unit 2003 Making the Connections: Final Report on Transport and Social Exclusion <http://po.st/uv0d89>

Spinney, J. 2009 Cycling the City: Movement, Meaning and Method. *Geography Compass* 3(2): 817–835.

Sport England/Department for Transport 2014 Local Area Walking and Cycling Statistics: England 2012/13 <http://po.st/7RazDO>

Steer Davies Gleave 2012 Cycle route choice: Final survey and model report. London: Transport for London/Steer Davies Gleave <http://po.st/PCQhRS>

Stefánsdóttir, H. 2014 Urban routes and commuting bicyclist's aesthetic experience. *FORMakademisk* 7(2) <http://po.st/KNuKAn>

Steinbach, R., Green, J., Datta, J. and 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 <http://po.st/4cWqWb>

Sustrans 2003 Traffic restraint and retail vitality. Bristol: Sustrans <http://po.st/XtN4k7>

Sustrans 2012 Locked Out: Transport Poverty in England. <http://po.st/PZ9niK>

Sztabinski, F. 2009 Bike Lanes, On-Street Parking and Business: A Study of Bloor Street in Toronto's Annex Neighbourhood Toronto Clean Air Partnership <http://po.st/j3UDUU>

Teschke, K., Harris, M.A., Reynolds, C.C., Winters, M., Babul, S., Chipman, M., Cusimano, M.D., Brubacher, J.R., Hunte, G., Friedman, S.M., Monro, M., Shen, H., Vernich, L. and Crompton, P.A. 2012 Route Infrastructure and the Risk of Injuries to Bicyclists: A Case-Crossover Study. *American Journal of Public Health*, Vol. 102, No. 12, pp. 2336-2343

Tiemens, H. and Molenaar, I. 2014 Impact Assessment of the Hague Traffic Circulation Plan 2011. Presented to the Modelling on the Move: Cycling and Transport Modelling event, January 2014 <http://po.st/Qc9rHg>

Titheridge, H., Christie, N., Mackett, R., Hernández, D.O. and Ye, R. 2014 Transport Poverty: a review of the evidence <http://po.st/MGknQS>

Transport for London 2006 Total vehicle delay for London: RNPR Technical Note 3. <http://po.st/DISRiz>

Transport for London 2009 Cycle freight in London: A scoping study. <http://po.st/MV2Zkk>

Transport for London 2009a Cycle journey time reliability: RNPR Traffic Note 11 <http://po.st/Mv5XJC>

Transport for London 2012 Attitudes towards Cycling <http://po.st/TYoxdc>

Transport for London 2013 London Greenways Monitoring Report 2012 <http://po.st/wl1ot>

Tuckel, P., Milczarski, W. and Maisel, R. 2014 Pedestrian injuries due to collisions with bicycles in New York and California *Journal of Safety Research* 51: 7–13

van Goeverden, K. and Godefrooij, T. 2011 The Dutch Reference Study: Cases of interventions in bicycle infrastructure reviewed in the framework of Bikeability. Copenhagen: University of Copenhagen <http://po.st/2c9VHi>

Vlachokostas, Ch., Achillas, Ch., Michailidou, A.V. and Moussiopoulos, N. 2012 Measuring combined exposure to environmental pressures in urban areas: An air quality and noise pollution assessment approach *Environment International* 39 (2012) 8–18

Wang, J.Y.T., Mirza, L., Cheung, A.K.L. and Moradi, S. 2012 Transforming Auckland into a bicycle-friendly city: Understanding factors influencing choices of cyclists and potential cyclists. *Australasian Transport Research Forum* <http://po.st/vWzg05>

Warburton, D.E.R., Charlesworth, S., Ivey, A., Nettlefold, L. and Bredin, S.S.D. 2010 A systematic review of the evidence for Canada's Physical Activity Guidelines for Adults, *International Journal of Behavioral Nutrition and Physical Activity* 11: 7:39 <http://po.st/JRB8sH>

Winters, M. and 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): 40-7

Winters, M., Babul, I., Becker, H.J.E.H., Brubacher, J.R., Chipman, M., Crompton, P., Cusimano, M.D., Friedman, S.M., Harris, M.A., Hunte, G., Monro, M., Reynolds, C.C.O., Shen, H. and Teschke, K. 2012 Safe Cycling: How Do Risk Perceptions Compare With Observed Risk? *Canadian Journal of Public Health* 103(Suppl. 3): S42-S47 <http://po.st/lwiOzA>

Winters, M., Sims-Gould, J., Franke, T. and McKay, H. 2014 "I grew up on a bike": Cycling and older adults *Journal of Transport and Health*, in press.

Woodcock, J. 2014 Modelling the Health Impact of a 10% mode share for cycling, report for British Cycling <http://po.st/5CrJmE>

Woodcock, J., Edwards, P., Tonne, C., Armstrong, B.G., Ashiru, O., Banister, D., Beevers, S., Chalabi, Z., Chowdhury, Z., Cohen, A., Franco, O.H., Haines, A., Hickman, R., Lindsay, G., Mittal, I., Mohan, D., Tiwari, G., Woodward, A. and Roberts, I. 2009 Public health benefits of strategies to reduce greenhouse-gas emissions: urban land transport *Lancet* 2009; 374: 1930–43 <http://po.st/kj26sC>

Woodcock, J., Givoni, M. and Morgan, A.S. 2013 Health Impact Modelling of Active Travel Visions for England and Wales Using an Integrated Transport and Health Impact Modelling Tool (THIM) *PLoS ONE* <http://po.st/K3SU4L>

Woodcock, J., Tainio, M., Cheshire, J., O'Brien, O. and Goodman, A. 2014 Health effects of the London bicycle sharing system: health impact modelling study *BMJ*. 2014; 348: g425 <http://po.st/6ipRrs>

World Health Organization 2009 Interventions on Diet and Physical Activity: What Works <http://po.st/78jb3w>

Zander, A., Passmore, E., Mason, C. and Rissel, C. 2013 Joy, Exercise, Enjoyment, Getting out: A Qualitative Study of Older People's Experience of Cycling in Sydney, *Australia Journal of Environmental and Public Health*, Volume 2013, Article ID 547453, 6 pages <http://po.st/8h7GpW/>

Zukin, S. 2012 The social production of urban cultural heritage: Identity and ecosystem on an Amsterdam shopping street *City, Culture and Society* 3: 281–291

British Cycling
Stuart Street
Manchester
M11 4DQ

T: +44 (0) 161 274 2000
E: info@britishcycling.org.uk
britishcycling.org.uk

