THE FUTURE OF TRANSPORT

PROJECT REPORT PPR865

Healthy mobility and road safety

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Executive summary

Active travel is beneficial in terms of health outcomes (both physical and mental) and also has benefits in terms of reduced congestion and improved air quality.

Substituting short car journeys with an active mode of transport has the potential to reduce congestion, air pollution and encourage a healthier lifestyle. However, walking and cycling have a higher risk of road traffic injury than travelling by car.

This work attempted to estimate the likely effects on safety of increasing levels of active travel, using National Travel Survey data, and road injury data from the Stats19 database.

Walking

Analysis of National Travel Survey data showed that, on average, 12km per person per year has potential to be walked instead of travelled by car (based on trips which are <1km in length). If all of these short car trips were replaced by walking this would represent a 4% increase in walking. Using current levels of risk, it is estimated there would be an additional 406 pedestrian casualties (of all injury severities) if half of the short trips currently carried out by car were replaced with walking.

Cycling

Analysis of National Travel Survey data showed that 406km per person per year has potential to be cycled instead of completed in a car (based on trips which are 1-8km in length). If all of these short car trips were replaced by cycling this would represent a 473% increase in cycling.

When estimating the change in casualty numbers if these short car trips were replaced with cycling, the analysis first estimated a safety in numbers (SiN) effect where the casualty rate is assumed to reduce with increased cycling.

Taking SiN into account, it is estimated that there would be a slight increase in cycling casualties (2,505 of all severities) compared with the current situation. This estimate is based on a modelled relationship between cycling risk and cycle travel which is not necessarily causal; there are other factors not considered which are likely to contribute to different safety levels in different areas. For example, those local authorities which have high levels of cycling and lower cycling risks may also have good cycling infrastructure.

The analysis suggests that the impact of SiN for cyclists is considerable. For comparison, using current levels of risk with no SiN adjustment, it is estimated there would be an additional 41,472 pedal cyclist casualties (of all injury severities) if half of the short trips currently carried out by car were replaced with cycling.

The modelling predicted that alongside the changes in pedestrian and cyclist causalities, there would also be a reduction in car occupant injuries of 2,171 because of fewer people driving. This means that there would be a net increase in casualties overall of 740 (although note that injury severity was not taken into account).

Some authorities have both active travel and road casualty targets. The results show that progressing towards both of these goals simultaneously may be challenging without additional road safety measures. SiN has the potential to act as an enabler for active travel,

but there is not currently a standard measure for SiN. In addition, more work is required to fully understand why SiN occurs and how to make design decisions that build it into active travel planning. It is still unclear to what extent SiN occurs naturally, and how much is through careful planning of aspects such as infrastructure and behavioural change interventions. Interventions aimed at encouraging more people to walk or cycle must incorporate measures to improve safety, both to avoid increasing the number of road casualties, and to manage public perception of the risks involved.

Further limitations of the work are that the modelling accounts for factors including mobility issues, age and access to a bicycle, but does not account for characteristics of each trip; for example, the availability of cycle infrastructure or hilliness of the route. The non-included variables may include some which are important factors in mode choice and in risk.

The benefits of active travel to health, the environment and congestion, also have not been considered in this analysis.

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1 Introduction

Active travel (defined as walking or cycling as an alternative to motorised transport for the purpose of making everyday journeys (Public Health England, 2016, p. 10)) is beneficial in terms of health outcomes (both physical and mental) and also has benefits in terms of reduced congestion and improved air quality.

In recent decades, promotion of sustainable or active travel, such as cycling and walking, has increased substantially all over the world. In urban areas, substituting short car journeys with an active mode of transport has the potential to reduce congestion, air pollution and encourage a healthier lifestyle (Jones, 2012).

However, as shown in Figure 1, walking and cycling have a higher risk of road traffic injury than travelling by car. Therefore a shift from car travel to active travel may cause an increase in the number of collisions or casualties.

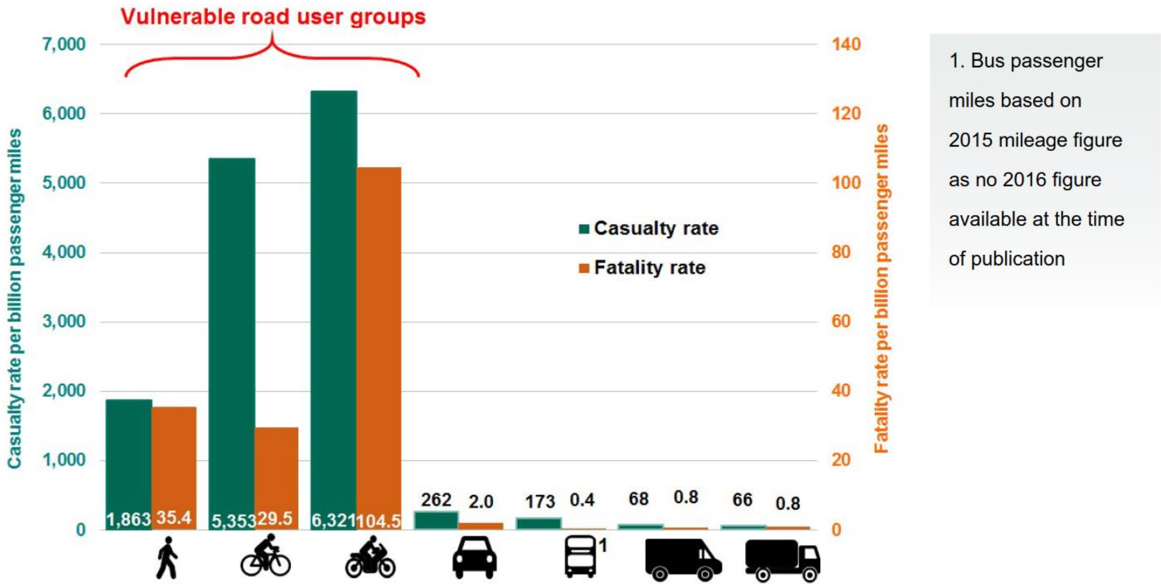

Figure 1: Casualty and fatality rates per billion passenger miles by road user type: GB, 2016 (DfT, 2017d, p. 7)

This project estimates the likely change in road accident casualties if a number of different active travel scenarios were implemented. This highlights the future challenge faced by government and local authorities to promote sustainable transport methods whilst also improving road safety and reducing collision numbers.

The first task in this project was to carry out a short literature review around the topic of casualties and active travel to see what research has been carried out in this area previously (see Section 2). In addition, the concept of safety in numbers, which has been suggested for cyclists, was reviewed to determine if there are any quantitative studies which can be used to understand whether the risk remains constant, independent on the amount of cycling, or whether this risk decreases as numbers of active travel users increase.

The second task sourced data from the National Travel Survey to understand the current rates of active travel (see Section 3). The data was used to identify the number of car trips that could potentially be undertaken on foot or by bicycle (e.g. short journeys).

Reported road casualty data (Stats19) and travel data for England were used to estimate the current risk of injury per kilometre travelled for each mode. This was combined with the findings from the National Travel Survey regarding the journeys which could be potentially walked or cycled to give estimates for the changes in casualties if the risks remained constant.

Further, the Stats19 data and travel data for each local authority in England were used to quantify a safety in numbers effect. This was used in combination with the active travel scenarios to estimate the reduction in risk associated with the increase in cycling, and hence to calculate the estimated number of casualties in each scenario. The outcome of this modelling is presented in Section 4.

2 Literature review

This section gives an overview of the method used to search the literature (Section 2.1) and presents the key themes identified in the literature review (Sections 2.2 to 2.5)

2.1 Method

A literature review was carried out to:

1. Identify other studies which have investigated the relationship between active travel and road accident casualties.
2. Understand the evidence around the issue of safety in numbers for pedestrians and cyclists.

Search terms were developed to gather literature relevant to these research questions (see Table 1). These search terms were applied to multiple online databases including Google Scholar, the Transport Research International Documentation (TRID) database and the ScienceDirect database. The search focused on literature from the past decade (from 2007 to 2017).

Table 1: Search terms and string for the literature review

"Safety in numbers"	AND	"active travel*" OR bicycl* OR cycl* OR pedestrian* OR walk*	AND	risk* OR injur* OR casualt* OR mortalit* OR death* OR kill* OR danger* OR jeopard* OR hazard* OR safety

A total of 25 papers, out of 36, were deemed relevant and of sufficient quality for the literature review.

2.2 Potential for active travel

In 2010, a study conducted by Transport for London (TfL) analysed growth in cycling potential from travel survey data of journeys in London. Results showed that around 8.17 million daily motorised trips made by Londoners could be replaced by cycling (Transport for London, 2017). Trips were excluded if they met the following criteria:

- The person making the trip is carrying tools or heavy work equipment, or a pram/pushchair.
- The trip is for commuting and is more than 10km, otherwise more than 8km. Age Trip is longer than 8km (or 10km for commuting) for those aged 5-64; 5km for ages 65-79 (all purposes); and 3km for age 80+ (all purposes).
- Trip made by van, dial-a-ride, plane or boat.
- The trip is part of a wider chain of trips that cannot be cycled in its entirety.

In a previous version of TfL's work (TfL, 2010) the criteria also excluded people with a disability, trips that would take 20% extra time to cycle and trips made between 8pm and 6am.

Similarly, following analysis of a long term travel survey in Belgium, Beckx *et al.* (2013) reported that 64% of journeys made by motorised transport in Belgium were less than 8km, corresponding to around 18% of the total fuel consumption, and could potentially be cycled.

Potential for active travel differs significantly by demographics like age and gender, and socio-economic factors like income, employment and car ownership. Fairnie *et al.* (2016) analysed London Travel Demand Survey data and found that adults in households without a car are more likely to travel by active modes of transport for at least 30 minutes on a given day compared to residents who owned cars. Additionally, statistics on walking and cycling released by Department for Transport (DfT) in England showed that women aged between 21 and 69 walk more often than men of the same age; and men cycle three times more often compared to women of the same age (DfT, 2018).

The implementation of policies and programmes aimed at reducing the dependence on motorised transport and encouraging walking and cycling have increased substantially over the last decade. Bikeshare programs, such as Santander Cycles in London, have been implemented in various cities around the world. These allow individuals to borrow bikes for short trips within a city; thus reducing the need for cars in busy cities. Promotion of such policies and development of cycling infrastructure can result in an increase in active travel time (Fishman, Washington, & Haworth, 2015). Fishman *et al.* (2015) gathered trip data from cities in the United States, Great Britain and Australia and found that there was an increase in active travel due to bikeshare programs; measured through increases in physical activity and time spent using active travel; on average, nearly 60% of bikeshare trips replaced other modes of transport. Hérick, Parra, & Monteiro (2015) also found that government policies aiming to replace motorised travel by active transportation could increase active travel time significantly, thus producing health benefits.

Various studies have different definitions of motorised journeys that could potentially be walked or cycled. In the Netherlands, car journeys less than 7.5km are considered short enough to potentially be cycled (Schepers & Heinen, 2013). A survey conducted by the DfT showed that 56% of car driver journeys in England were less than 5 miles and 17% between 1 and 2 miles (DfT, 2016a); these data are explored further in Section 3. Beckx *et al.* (2013) identified car journeys under 8km as the threshold distance for potential substitution. However, distance is not the only factor that determines the potential in shift to active travel; other factors such as the presence of passengers, carrying of heavy goods, journey destination and cycling infrastructure play a vital role in the decision to walk or cycle.

2.3 Effect of modal shift to active travel on casualties

A modal shift from motorised transport to non-motorised travel can reduce congestion and pollution; however, road safety is still the primary obstacle to this shift and presents an elevated risk of injury. Evidence on the impact of modal shift on collision risk can be found from a study conducted in the Netherlands by Schepers & Heinen (2013). Collision and exposure data, collected over a six year period, were used to build Accident Prediction Models (APMs) to estimate collision risk for road users when short car trips were substituted by more active modes of travel. The findings were interesting as they showed no change in the number of fatalities due to the modal shift, but an increase in the number of serious injuries. However, the relative risk for injury was found to differ by age.

2.4 Casualty rates and safety in numbers

In a mixed traffic environment, each road user has a different risk of injury and this risk can change depending on the balance of road users in the surrounding area. The theory of safety in numbers (SiN) was first described by Jacobsen in 2004. He described it as safety in numbers: more walkers and bicyclists, safer walking and bicycling' (Jacobsen, 2004). He also suggested that the relationship between the number of pedestrians and cyclists and the number of collisions between them and motorists is non-linear. His study highlighted there was a decline in collision rates as the number of VRUs (pedestrians and cyclists) increased.

Multiple studies have supported the theory of SiN and attempted to understand the reason behind this.

The relationship between cyclist casualties and cyclist population in cities across England was analysed by Road Safety Analysis (Road Safety Analysis Limited, 2016). There was a large amount of variation between cities and there was not an overall linear relationship between the cyclist casualty rate and the cycling level. Cities were divided into four groups:

- High levels of cycling and high cyclist casualty rate
- Low levels of cycling and high cyclist casualty rate
- Low levels of cycling and a low cyclist casualty rate
- High levels of cycling and a low cyclist casualty rate

A linear trend was applied to each group, with each showing that cities with a higher level of cycling had a lower casualty rate. The effect was strongest for cities in the low cycling level-high rate group; whilst in the cities with high cycling levels the effect was smaller.

The cycling level and the risk level is also likely to depend upon other variables such as the characteristics of the cyclists, the cycling infrastructure present, the amount of cycling training available, road type and traffic, terrain, rural/urban, publicity related to cycling and road safety, public transport availability and the weather.

A common belief is that as more drivers start cycling or walking, they are generally more considerate towards cyclists when driving themselves. Johnson *et al.* (2014) tested this concept using self-reported behaviour, knowledge and attitudes of around 2000 Australian drivers (who could also be cyclists) in relation to cycling. The study found that drivers who were also cyclists were generally more considerate towards cyclists, had better knowledge of cycling infrastructure and rules; whereas drivers who did not cycle were less considerate towards cyclists and did not report a positive attitude towards them. For instance, drivers were less likely to provide adequate distance when overtaking cyclists, or indicate prior to turning. These findings suggested the need for increased road awareness and education for drivers.

Even though active travel has increased over the years, road user safety is often cited as the primary barrier to the uptake of active travel. Thus, the majority of newer research has estimated collision risk for each road user type to understand the theory of SiN using various statistical techniques such as negative binomial regression and multinomial logistic models. For instance, Kaplan & Prato (2015) applied a joint model of frequency and severity on a sample of 5000 cyclist-motorist collisions in Copenhagen to estimate the risk of being in a collision and the severity of the injury, if involved in a collision. Results highlighted a reduction in the number of severe collisions from greater numbers of cyclists, thus confirming the existence of SiN. In agreement with these findings, studies conducted across Sweden, Norway and France used accident data and exposure data (from travel surveys) to estimate the collision risk for road user types (Elvik, 2016; Kröyer, 2016; Blaizot, Papon, Haddak, & Amoros, 2013; Elvik, Sørensen, & Nævestad, 2013); and found that the collision risk for bicyclists reduced significantly as exposure increased; and that there was a reduction in the severity of the injury. Furthermore, Kröyer (2016) found that the relationship between collision risk and number of cyclists is non-linear and complex to estimate.

Contrary to other studies, Elvik (2017) estimated the strength of the SiN effect and found that the effect is stronger when there are fewer VRUs. This finding is counterintuitive and suggests that although the concept of SiN has been shown, further research is required to understand the complexity of this effect.

In addition to model based predictions, Thompson *et al.* (2016) found that the effect of SiN could be replicated in a simulated environment using Rescoria-Wagner leaning models[1], and the results were consistent with studies using real data. The model also showed that an exponential relationship exists between cyclist collision risk and exposure.

2.5 Barriers to uptake of active travel

Infrastructure, road safety and environmental factors are common obstacles to the uptake of active travel, mainly cycling. Governments and other authorities have commissioned multiple studies to understand the current cycling levels in cities, the most common barriers to cycling and identify ways to overcome those barriers, for its numerous economic, environmental and health benefits ((Bauman, et al., 2008), (Transport for London, 2016)).

Bauman *et al.* (2008) suggest there are multiple obstacles to adults cycling in Australia such as poor health, lack of time and road safety. These obstacles also tend to differ but gender with women considered the ability to carry things on a bike as a major barrier compared to men. Fowler *et al.* (2017) analysed data collected from 1,300 residents in Baltimore to explore the relationship between gender and barriers to cycling. Results showed that non-riding women found road safety to be the main obstacle to active travel; in particular, the impact of the weather and the presence of car drivers on perceived safety.

Some of the key recommendations to overcome barriers to cycling include marketing campaigns, cycling education programs, urban design, and setting up bicycle infrastructure. Osama & Sayed (2016) used cyclist-motorist collision data across 134 traffic zones in

[1] In Rescoria-Wagner models, learning is defined in terms of association between conditioned and unconditioned stimuli. In road transport, this translates to the association between the act of driving and expectation of encountering cyclists on the road.

Vancouver to develop collision prediction models and found that presence of bicycle infrastructure reduces cyclist collisions. Marqués & Hernández-Herrador (2017) observed collision risk for cyclists before and after the implementation of a bicycle network infrastructure in Seville, Spain. The study found a positive impact of the network infrastructure on the collision risk for cyclists. This finding is crucial as it suggests that government should focus on mitigating collision risk for cyclists whilst encouraging cycling participation.

Apart from physical mechanisms to encourage cycling, driver behaviour is essential to improve cyclists' safety. As discussed in the previous section, as more drivers start cycling, they tend to be more considerate towards cyclists when driving themselves. Thompson *et al.* (2017) suggested that segregated bicycle infrastructure along with greater driver consideration towards cyclists may reduce casualty numbers. In fact, if driver behavioural adaptation is assumed to be strong enough (i.e. drivers detect the presence of a cyclist and change their behaviour accordingly) then a few kilometres of bicycle infrastructure may not impact casualty numbers.

In London, around 0.75 million motorised trips that could be cycled are made by people who cycle at least once a week (Transport for London, 2016). This shows potential to encourage cyclists to cycle more frequently. However, the willingness to change behaviour, both driver and cyclist, and increased focus on cyclist safety from authorities are probably the most crucial factors in the uptake of cycling.

The 2015 British Social Attitudes survey (DfT, 2017a) asked about whether short car journeys could be walked and whether people agreed with the statement 'it is too dangerous for me to cycle on the roads'. The results are shown in Figure 2.

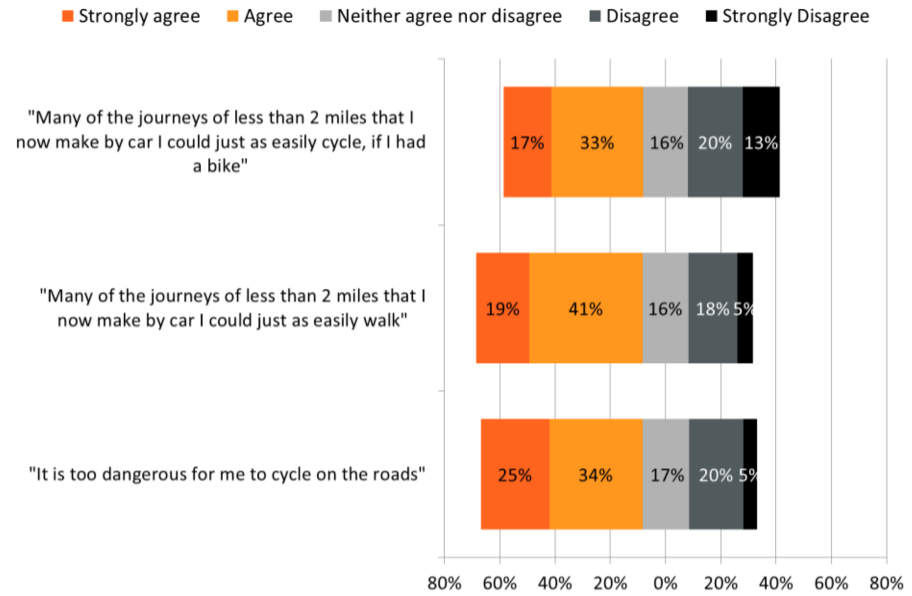

Figure 2: Proportions agreeing and disagreeing with statements (DfT, 2017a) (ATT0313, ATT0315, ATT0317) (Not including 'not answered' or 'never/rarely by car')

This shows that 50% of respondents agreed that many short journeys currently made by car could be cycled and 60% that they could walk. 59% of respondents agreed to the statement 'it is too dangerous for me to cycle on the roads'. Responses to this statement were disaggregated by gender, age band, cycling and driving status – see Figure 3 (DfT, 2018).

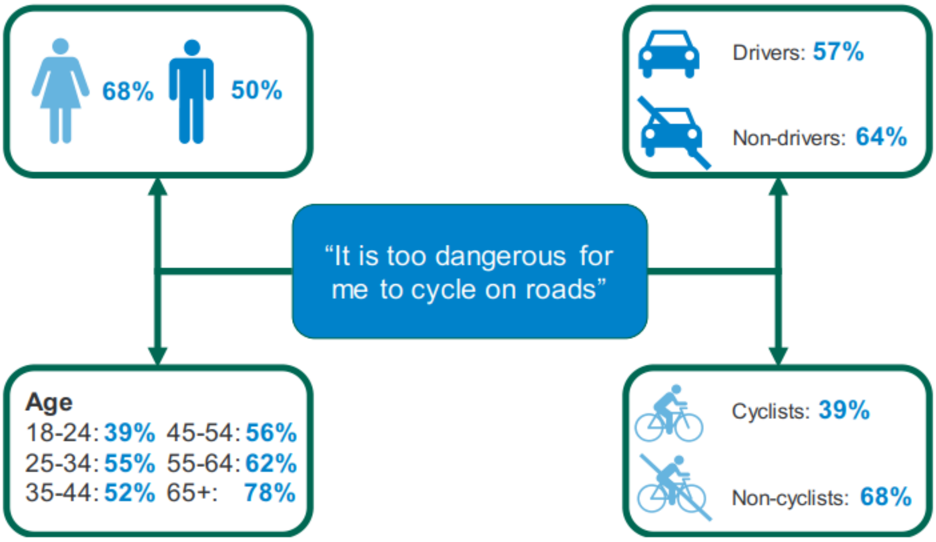

Figure 3: Percentage of adults aged 18+ who agree with the statement "It is too dangerous for me to cycle on the roads" (DfT, 2018)

Participants in the National Travel Survey (NTS) were also asked to rate how good the provision of cycle paths were in the area within five miles of their house. This question was answered once by each household. 33% of households responded that they did not use the cycle lanes or had no opinions about how good the cycle lane provision was and 13% of households said that there were no cycle lanes within five miles of their house (DfT, 2017c). Figure 4 shows the responses of the remaining 54% of households.

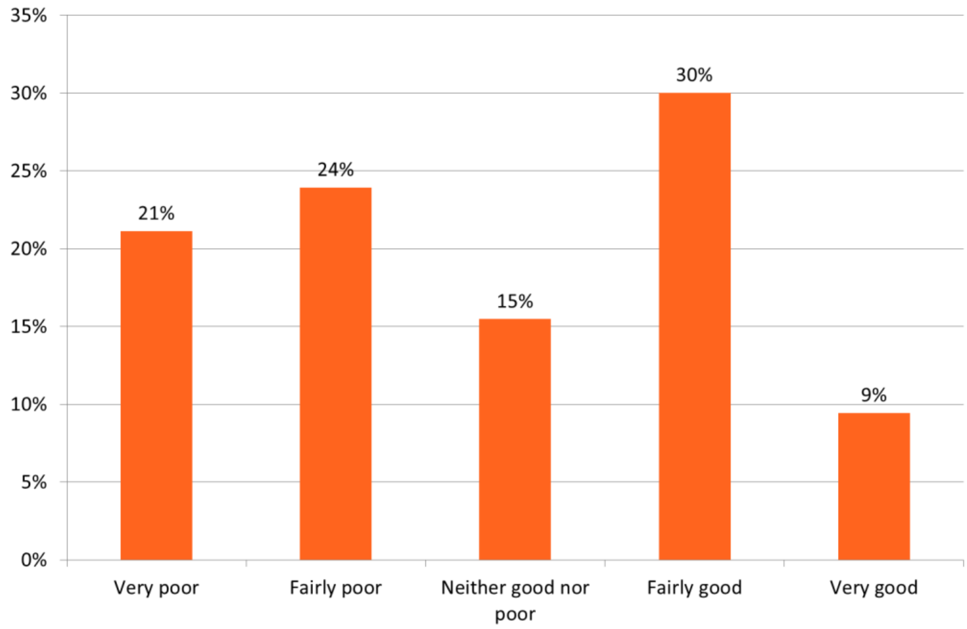

Figure 4: Proportion of households by opinion of cycle lane provision, 2015 (n = 4,051) (DfT, 2017c)

Slightly more households had a negative view of the cycle lane provision in their area than had a positive view (45% compared to 39%).

The NTS also contained a question about the barriers that stop people cycling. Individuals were asked for reasons why they did not cycle more. Their responses are shown in Table 2. Note that participants could select more than one reason for not cycling from the list given to them so the percentages in Table 2 do not sum to 100%.

Table 2: Reasons for not cycling more, 2015 (DfT, 2017c)

Reason for not cycling more	Number of people	Proportion of total
Easier / quicker to go by car	3,730	22%
Got a car / learnt to drive	3,647	22%
Lack of time / too busy	3,085	18%
Ill-health / too old	2,790	17%
Too much traffic / traffic too fast	2,690	16%
Road safety concerns	2,614	15%
General lack of interest / motivation	2,396	14%
Bike broken / don’t own a bike	1,829	11%
Drivers attitudes towards cyclists	1,460	9%
Other	1,274	8%
Weather	1,240	7%
Poor road surfaces / street lighting	1,155	7%
Lack of cycle routes	1,019	6%
Cycle enough already	818	5%
Personal security concerns	486	3%
Nowhere safe to leave the bicycle at destination	427	3%
Switched to public transport	229	1%
TOTAL people who gave reasons for not cycling	**16,900**	**100%**

The two most common reasons for not cycling more were ‘easier/quicker to travel by car’ and ‘got a car/learnt to drive’. The latter suggests that people may only be choosing to cycle when travelling by car is not an option. Two of the top three reasons for not cycling more (‘easier/quicker to go by car’ and ‘lack of time/too busy’) are related to driving being quicker than cycling suggesting that journey time is a factor that is important to people. Only 15% of people said they did not cycle more because of concerns about road safety; lack of cycle routes (6%) and too much traffic or traffic too fast (16%) were also concerns.

3 Characteristics of trips (NTS)

The following sections report analysis of National Travel Survey (NTS) data from 2015. This is an annual survey of households in England. Each individual in a surveyed household records their travel over a week[2] in a travel diary; the totals reported in this section refer to the number of trips recorded across all households in this week. The survey also includes details of individuals and households such as demographics and vehicle ownership.

The data collected as part of the NTS is weighted to reduce the effects of non-response bias and drop-off in number of trips across the week recorded. The data are also weighted to ensure that the characteristics of the sample match the population of England. The results reported in this document are all based on analysis of the weighted data.

This section reviews the mode share by trip length for all journeys, reviews characteristics of short trips and considers which types of short trips have potential to be walked or cycled.

3.1 All journeys

Table 3 shows the total number of trips recorded by participants in one week. Note that the mode of transport reported here is the main mode of transport for the journey but other modes of transport may also have been used. The main mode of a trip is defined as the mode that is used for the longest stage of the trip by distance. If there are stages of equal length then the mode of the latest stage is used.

Table 3: Number of trips by main mode of transport and trip length, 2015 (km) (DfT, 2017c)

Main mode	<1km	1-<4km	4-<8km	8-<12km	12-<16km	16-<20km	>20km	Total
Walk	1,009	33,081	19,153	5,825	808	269	218	**60,363**
Bicycle	660	2,033	1,229	485	350	163	236	**5,155**
PTW	7	87	184	114	128	27	273	**819**
Car	6,154	49,835	40,698	21,593	13,333	8,972	32,326	**172,911**
Taxi/minicab	56	1,046	840	323	263	84	314	**2,925**
Van/lorry	141	974	776	426	287	237	1,031	**3,873**
Bus	255	4,818	6,451	3,286	1,813	942	2,378	**19,943**
Underground	4	140	417	442	394	303	1,071	**2,770**
Rail	2	214	449	783	620	512	4,283	**6,863**
Air	-	-	-	-	1	-	30	**31**
Other	115	275	98	89	40	41	211	**869**
TOTAL	**8,404**	**92,504**	**70,294**	**33,365**	**18,036**	**11,548**	**42,371**	**276,521**

[2] Different households are surveyed in weeks throughout the year so that seasonal effects are reduced.

Table 3 shows 63% of reported journeys were made by car and 56% of these car journeys were journeys of less than 8km. The second most frequent mode of transport reported was walking (29% of total reported journeys) and 88% of these were journeys of less than 8km. Journeys made by bicycle accounted for only 2% of the total number of journeys reported and the majority of these were journeys between 1km and 8km in length.

Table 4 shows the total number of kilometres travelled by each mode of transport split by the length of trip in which they were travelled. Note that because trips can be made up of multiple stages using different modes of transport the number of kilometres travelled by car during a trip might not be the same as the total trip length.

Table 4: Kilometres travelled by main mode of transport and trip length, 2015 (km) (DfT, 2017c)

Main mode	<1km	1-<4km	4-<8km	8-<12km	12-<16km	16-<20km	>20km	Total
Walk	393	41,417	22,216	7,350	1,373	648	731	**74,128**
Bicycle	440	4,358	5,604	3,961	3,696	1,865	5,262	**25,187**
PTW	5	207	1,034	1,034	1,375	436	10,584	**14,675**
Car	4,388	120,539	219,680	195,151	168,205	145,188	1,582,560	**2,435,711**
Taxi/minicab	43	2,625	4,272	2,788	2,437	1,282	10,949	**24,396**
Van/lorry	97	2,141	4,192	3,802	3,429	3,588	50,027	**67,277**
Bus	258	12,837	33,984	26,797	19,755	13,561	88,895	**196,087**
Underground	3	477	2,685	4,251	4,878	4,617	22,456	**39,368**
Rail	2	653	2,795	7,587	7,849	8,326	299,981	**327,192**
Air	-	-	-	-	14	-	19,574	**19,587**
Other	70	579	654	704	569	757	10,138	**13,471**
TOTAL	**5,700**	**185,833**	**297,115**	**253,426**	**213,580**	**180,268**	**2,101,158**	**3,237,079**

Similarly to what is shown in Table 3; Table 4 shows that the majority (75%) of kilometres reported were travelled by car. 16% of the distance travelled using this mode was on trips of less than 8km.

3.2 Short car journeys

This section gives more details regarding short car journeys, to assist in determining which journeys have the potential for active travel.

Trips recorded in the National Travel Survey are made up of different stages. A new stage is started every time a different mode of transport is used or there is a change of vehicle requiring a separate ticket.

Two kinds of short car journey were identified where the trip or one stage of the trip could potentially be walked or cycled:

- Single-stage trips of less than 8km made by car.

- Multi-stage trips where the first stage is less than 8km and made by car (only the first stage was considered because it is likely that the number of trips where the middle or last stage is travelled by car but the first stage is not would be very small)

The choice of 8km as the maximum length of a short car trip is based on previous studies explored in the literature review in Section 2 (Transport for London, 2017), (Schepers & Heinen, 2013).

There were a total of 97,606 trips in these two categories recorded in the NTS in 2015. However, trips in the second category (multi-stage trips where the first stage is less than 8km and made by car) accounted for only 1% (1,261) of these and so it was decided to limit the analysis to trips in the first category only. Therefore, short car journeys in this analysis are defined as single-stage trips of less than 8km made by car. There were 96,345 of these trips recorded in the NTS in 2015.

3.2.1 *Characteristics of short car trips*

Figure 5 shows the proportion of short car trips by trip length.

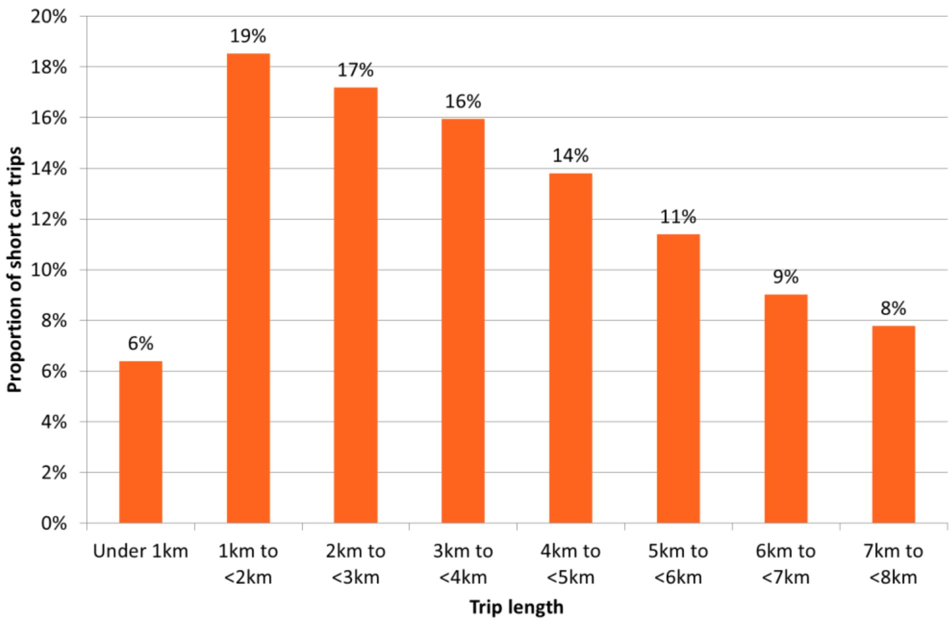

Figure 5: Proportion of short car trips by trip length, 2015 (n = 96,345) (DfT, 2017c)

The "Under 1km" category has the fewest number of trips (6%), probably because it is rare for people to have all the places they most frequently need to travel to (e.g. work, school, shops) within 1km of where they live. Also, some of the trips under 1km may already be being walked or cycled. The highest proportion of short car journeys are between 1km and 2km in length and the proportion of short car trips decreases as the trip length increases.

Table 5 shows the number of short car trips recorded in the NTS in 2015 by trip purpose.

Table 5: Number of short car trips by trip purpose, 2015 (DfT, 2017c)

Trip purpose	Number of trips	Proportion
Shopping	21,935	23%
Visiting friends	14,229	15%
Other escort	13,052	14%
Personal business	11,183	12%
Commuting	9,605	10%
Escort education	7,185	7%
Entertainment	6,302	7%
Education	5,225	5%
Day trip	3,210	3%
Business	2,194	2%
Sport	1,762	2%
Holiday	449	<0.5%
Other (including just walk)	14	<0.5%
TOTAL	**96,345**	**100%**

The highest proportions of trips were for shopping (23%), visiting friends (15%) and escorting people to places (e.g. taking children to a friend's house) (14%). Some of these journeys could potentially be done on foot or bicycle; however, not enough detail is known about trip purpose to assume that all trips for a certain purpose could be walked or cycled. For example, shopping trips could include trips to a corner shop, a shopping mall, supermarket, furniture or DIY store and each could result in differing amounts of shopping, resulting in difficulties with transporting any goods purchased home if the trip was completed by walking or cycling.

Participants in the NTS also record the start and end times of each trip they make, although there are a small number of trips for which this information has not been recorded. Figure 6 shows the proportion of short car trips by time of trip start (for trips where this information is known).

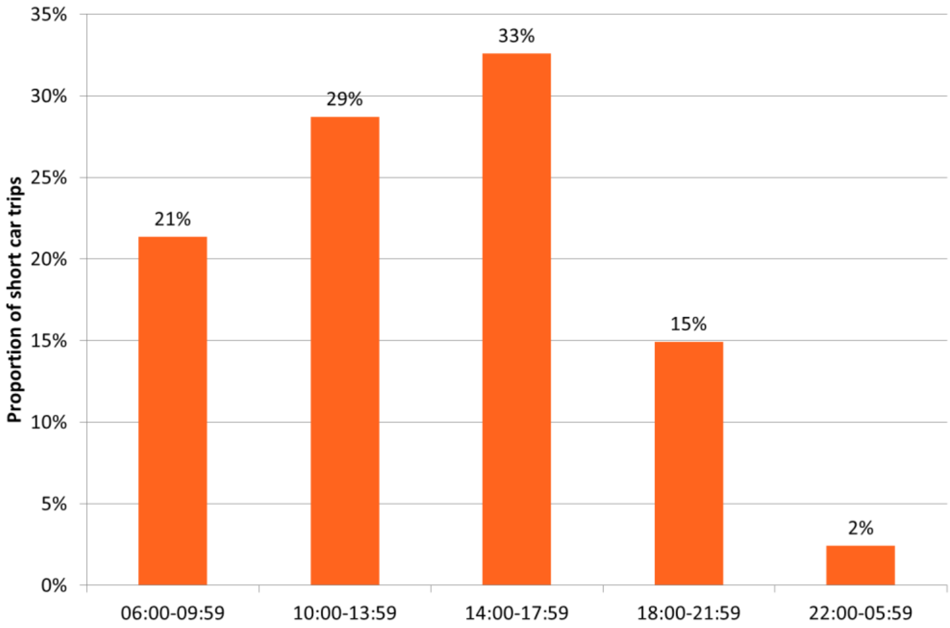

Figure 6: Proportion of short car trips by time of trip start, 2015 (n = 95,050[3]) (DfT, 2017c)

The majority (83%) of short car trips were made during the day (between 6am and 6pm) with the most common time for short car trips being between 2pm and 6pm.

3.2.2 Trips that could be walked or cycled

This section provides details of short car journeys reported in 2015 that could have been walked or cycled instead of driven. The criteria were developed based on the data analysis in the previous section and the literature review.

The criteria that need to be met for a trip to be considered potentially walkable are:

- The trip is less than 1km in length (this equates to a time of up to 12.5 minutes at an easy pace of 3 miles per hour)
- The person making the trip has no mobility difficulties that stop them travelling by foot
- The person making the trip is less than 70 years old

The criteria that need to be met for it to be considered as a potential bicycle trip are:

- The trip is between 1km and 8km in length (this equates to up to 30 minutes at a pace of 10 miles per hour)
- The person making the trip has no mobility difficulties that stop them travelling by foot
- The person making the trip is between 10 and 70 years old
- The person making the trip has access to a bicycle

[3] 1,295 short car trips did not have time of trip recorded.

Note that these criteria will exclude some longer journeys that could be cycled and, as discussed above, there are also many unknowns about trips which mean that some of these trips that are identified as having potential for active travel could not be walked or cycled in practice.

There are 18,264 short car journeys for which it is unknown whether the person making the trip had mobility difficulties. Almost all of these trips (99%) were made by people under 16 years old for which mobility difficulties are not recorded. Therefore it was assumed that the trips where it is unknown whether the person making the trip had mobility difficulties or not were made by children without mobility difficulties.

Figure 7 shows the criteria applied to the 6,153 car journeys less than 1km to identify how many of these journeys could have been walked. Light grey boxes indicate trips which were excluded at each level and orange boxes indicate trips which were included.

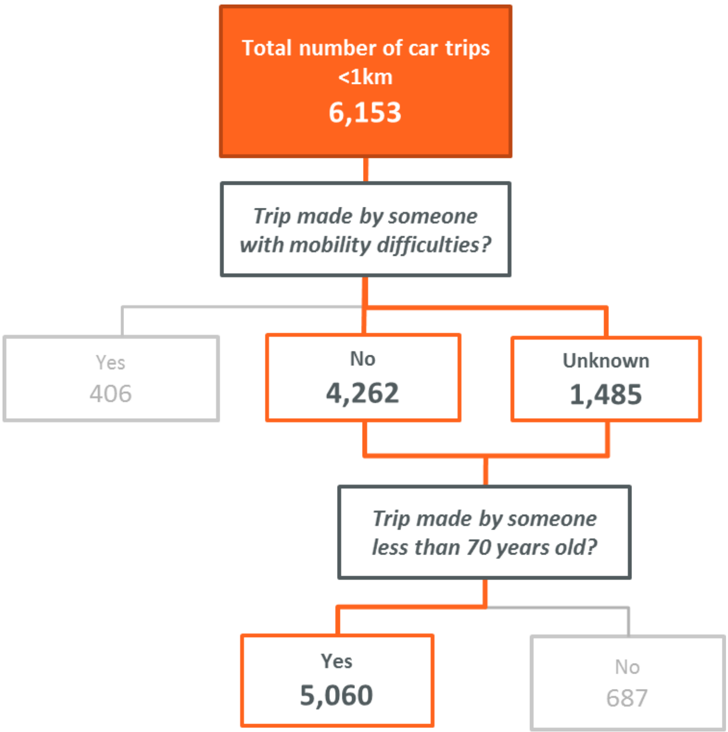

Figure 7: Tree showing criteria applied to identify trips that could have been walked (DfT, 2017c)

Figure 7 shows that there were 6,153 car trips of less than 1km recorded in the NTS in 2015. Of these, 5,060 trips (82%) were made by people aged less than 70 years old and with no mobility difficulties and could potentially have been walked. By applying the criteria in Figure 7 it was calculated that an average of 12km per person could have been walked instead of driven in 2015.

There were 90,192 car journeys between 1km and 8km in length recorded in the NTS in 2015 and Figure 8 shows the criteria used to identify how many of these journeys could have been cycled.

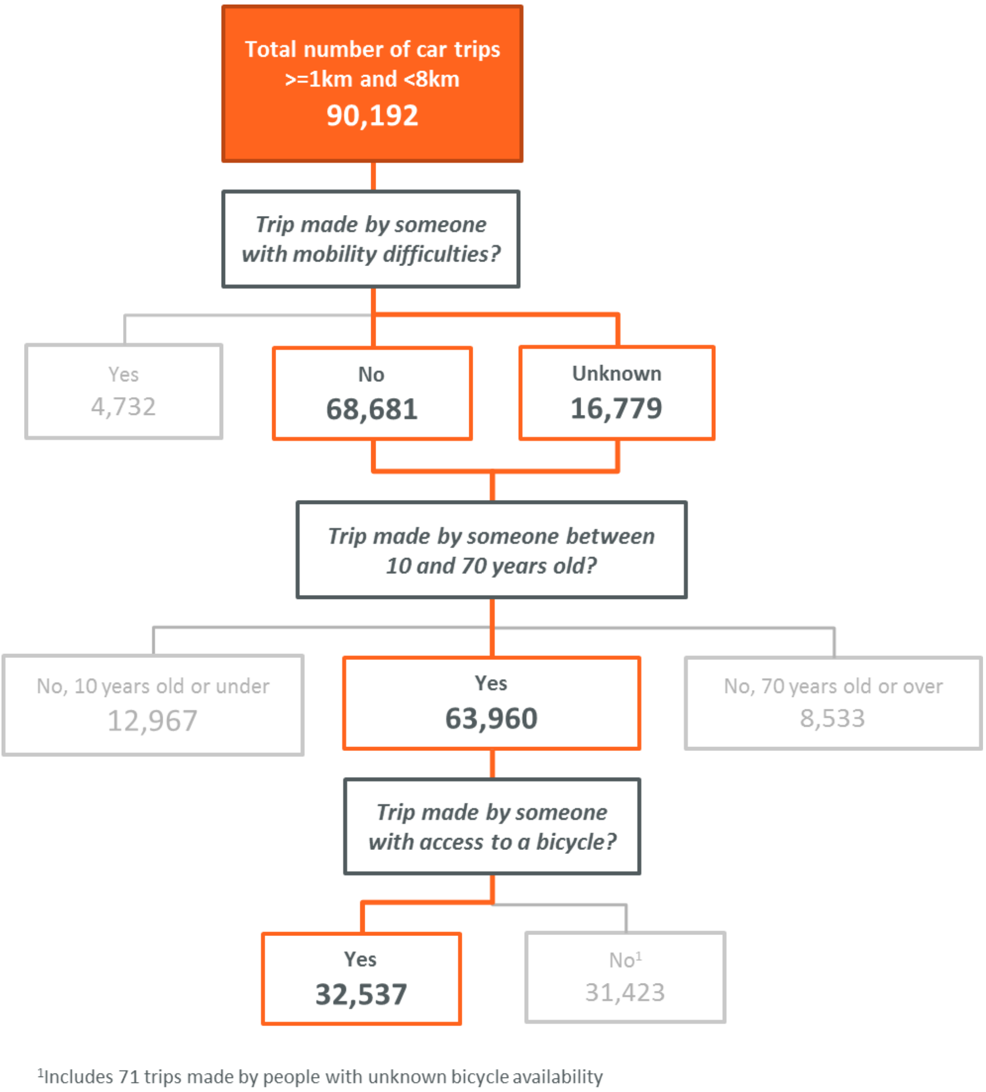

Figure 8: Tree showing criteria applied to identify number of trips that could have been cycled (DfT, 2017c)

As seen in Figure 8, there were 90,192 trips between 1km and 8km in length. Of these, 32,537 trips (36%) could potentially have been cycled instead of driven; i.e. the trips were made by people who had no mobility difficulties, were between 10 and 70 years old and had access to a bicycle. From these 32,537 trips it was calculated that an average of 406km per person could have been cycled instead of driven in 2015.

3.2.3 Total distance that could be walked or cycled

The estimates for the number of kilometres per person that could have been walked or cycled in 2015 were used to calculate the total distance that could be walked or cycled across the whole population of England in a year. This was calculated by multiplying the estimated potential distance per person in Section 3.2.2 by mid-year population estimates (shown in Table 14) to give the total distance with potential to be walked or cycled as shown in Table 6.

Table 6: Total distance with potential to be walked or cycled

Trips with potential for:	Total number of trips	Average distance per person per year (km)	Total distance per year (million km)
Walking	5,060	12	655
Cycling	32,537	406	22,225

These figures are used in Section 4.2 to calculate the potential change in casualty numbers for different scenarios.

4 Estimated changes in casualties for active travel scenarios

The aim of this section is to investigate the estimated changes in casualty numbers if people were to switch their mode of transport for short journeys from driving to either walking or cycling, based on the short journeys identified in Section 3.2. Two assumptions are applied:

- The current casualty rates remain the same (Section 4.2)
- A safety in numbers scenario for cycling where the casualty rate reduces with increased cycling level (Section 4.4)

Firstly, the current risk levels by mode are shown in Section 4.1.

4.1 Casualties, travel and risks by mode

Stats19 is the national database of reported injury collisions and only includes those collisions reported to and by the police. Whilst most fatal collisions are reported to the police, there is evidence that some serious and slight collisions are not reported to the police as hospital, survey and compensation claims data all indicate a higher number of casualties than those suggested by Stats19 (DfT, 2017e). A review of studies relating to underreporting of collisions involving cyclists to the police (Knowles, et al., 2009) suggested that underreporting was particularly acute when no motor vehicles were involved, with one study estimating that cyclists casualties should be increased by a factor of 5.73 for serious and 2.35 for slight, and another estimating the corresponding factors to be 2.95 and 1.25. These factors have not been accounted for here. Therefore the casualty rates for cyclists should be considered as underestimates.

The number of casualties reported by severity and road user group in 2015 is shown in Table 7.

Table 7: Number of casualties by road user group, GB 2015 (Table RAS30001) (DfT, 2017b)

Road user group	Killed	Seriously injured	KSI	Slightly injured	All casualties
Pedestrians	408	4,940	5,348	18,713	**24,061**
Cyclists	100	3,239	3,339	15,505	**18,844**
Motorcycle users	365	5,042	5,407	14,511	**19,918**
Car occupants	754	7,888	8,642	103,065	**111,707**
Bus and coach occupants	5	275	280	4,346	**4,626**
Goods vehicle occupants	65	561	626	5,447	**6,073**
All road users	**1,730**	**22,144**	**23,874**	**162,315**	**186,189**

This shows that 60% of all road casualties were car occupants and 23% were pedestrians or cyclists. These active modes have a higher severity, with 22% of pedestrian casualties and 18% of cyclist casualties Killed or Seriously Injured (KSI) compared with 8% for car occupants.

Table 8 shows the casualty passenger rates by mode based on the Stats19 casualty data and the travel data in terms of total passenger km.

Table 8: Casualty passenger rates by mode (Per billion passenger kilometres), GB 2015 (Table RAS53001) (DfT, 2016b)

Road user group	Killed	KSI	All
Pedestrians	22	287	1,290
Cyclists	19	641	3,618
Motorcycle users	76	1,126	4,148
Car occupants	1.1	13	170
Van occupants	0.3	4	47
Bus or coach occupants	0.1	7	117

This shows that car and van travel carries the lowest risk per km travelled, and that motorcyclists and cyclists have the highest risk.

The National Travel Survey data which was used as a basis for the scenarios later in this report covers England only. Therefore the casualties and exposure and casualty rate data were derived for England only.

Table 9 gives the total casualties and the estimates for the travel and casualty rates for England based on Stats19 casualty data, NTS and population data. Further details on how these were derived are given in Appendix A.

Table 9: Casualty, travelling and risk for pedestrians, cyclists and car occupants, England 2015

Road user group	Casualties	Travel (billion passenger km)	Casualty rate (casualties per billion passenger km)
Pedestrians	21,525	16.1	1,335
Cyclists	17,541	4.7	3,732
Car occupants	99,684	532.9	187

As with the data for GB (Table 8), this shows that cyclists and pedestrians have a higher risk than car occupants, with the casualty rate 20 and 7 times higher than that for car occupants respectively. Therefore an individual switching a car trip to a more active mode is exposed to a greater risk, and if these risk levels remain constant, an increase in casualties would be expected, as calculated in Section 4.2.

4.2 Scenario analysis results – constant risk

This section contains the results of the scenario analysis. These results assume that the casualty rate for all transport modes is constant and is not affected by safety in numbers. It is presented here as a comparator to illustrate the changes we might expect in casualties if the SiN phenomenon did not occur.

These calculations involve estimating the total distance that could be travelled using an active travel mode (walking or cycling) – this is based on the analysis of trip lengths detailed in Section 3.2. This distance is then subtracted from the total distance travelled by car and added to the total distance travelled by walking or cycling, and the resultant casualties estimated by multiplying the new distance travelled by the risk per kilometre for that mode.

A number of different scenarios have been investigated. The current scenario represents no additional active travel (0% uptake) and 100% uptake represents all of the short car journeys identified in Section 3.2 switched to active modes. Each scenario represents a different level of uptake of active travel and assumes equal levels of uptake for walking and cycling. For example, the 75% uptake scenario considers the outcome if 75% of the total distance that could be walked instead of driven was walked, and if 75% of the total distance that could be cycled instead of driven was cycled.

Table 10 shows the passenger kilometre and casualty estimates by mode of transport for the current scenario (0% uptake) and for the 25%, 50%, 75% and 100% uptake scenarios

Table 11 shows the absolute change and the percentage change in casualty numbers for each transport mode relative to the current scenario (0% uptake). The total change in casualties across all modes is also shown.

Table 10: Estimated casualties for active travel scenarios

		Car occupants	Pedestrians	Cyclists
Current scenario (0% uptake)	Billion passenger km	532.9	16.1	4.7
	Casualties	99,684	21,525	17,541
25% uptake scenario	Estimated billion passenger km	527.2	16.3	10.3
	Casualty estimates	98,583	21,712	38,276
50% uptake scenario	Estimated billion passenger km	521.5	16.4	15.8
	Casualty estimates	97,513	21,931	59,013
75% uptake scenario	Estimated billion passenger km	515.7	16.6	21.4
	Casualty estimates	96,443	22,150	79,749
100% uptake scenario	Estimated billion passenger km	510.0	16.8	26.9
	Casualty estimates	95,374	22,368	100,485

Table 11: Change in casualty numbers relative to current scenario (0% uptake)

Scenario	Car occupants		Pedestrians		Cyclists		Total casualties	
	Change	% change	Change	% change	Change	% change	Change	% change
25% uptake	-1,101	-1%	187	1%	20,735	118%	19,821	14%
50% uptake	-2,171	-2%	406	2%	41,472	236%	39,706	29%
75% uptake	-3,241	-3%	625	3%	62,208	355%	59,591	43%
100% uptake	-4,310	-4%	843	4%	82,944	473%	79,476	57%

Table 10 shows that, compared with the current scenario, if all short car trips were replaced with walking and cycling (i.e. the 100% scenario), car travel would decrease by 22.9 billion passenger kilometres, and this would be substituted for increase in walking of 0.7 billion passenger kilometres and an increase in cycling of 22.2 billion passenger kilometres.

Table 11 shows that there would be a small increase in pedestrian casualties and a small decrease in car occupant casualties between the current and 100% uptake scenarios. The change in cycling casualties is much larger with 17,541 in the current scenario (0%) uptake increasing more than five-fold to 100,485 cyclist casualties in the 100% uptake scenario. This is an increase of 82,944 casualties compared to an increase of 843 pedestrian casualties and a decrease of 4,310 car occupant casualties between the two scenarios, giving a net increase in casualties of over 75,000, an increase of 57% from the current scenario.

4.3 Safety in numbers

One of the phenomena identified in the literature review was the safety in numbers (SiN) effect. This is the effect that increased travel has on the casualty rate, especially for cycling. In order to estimate the SiN effect in these data, cyclist casualty data from Stats19 were analysed together with travel data from the NTS in order to investigate this relationship between travel and casualty rate further. For each local authority in England, the cyclist casualty rate (cyclist casualties per billion passenger kilometres) was calculated and then plotted against the number of kilometres cycled per person per year in that local authority. Figure 9 shows these results[4].

[4] Local authorities where the number of people in the NTS sample who reported cycling was less than ten have been excluded from this analysis in order to avoid biasing estimates for cycling kilometres per person per year on a very small sample of people who had cycled.

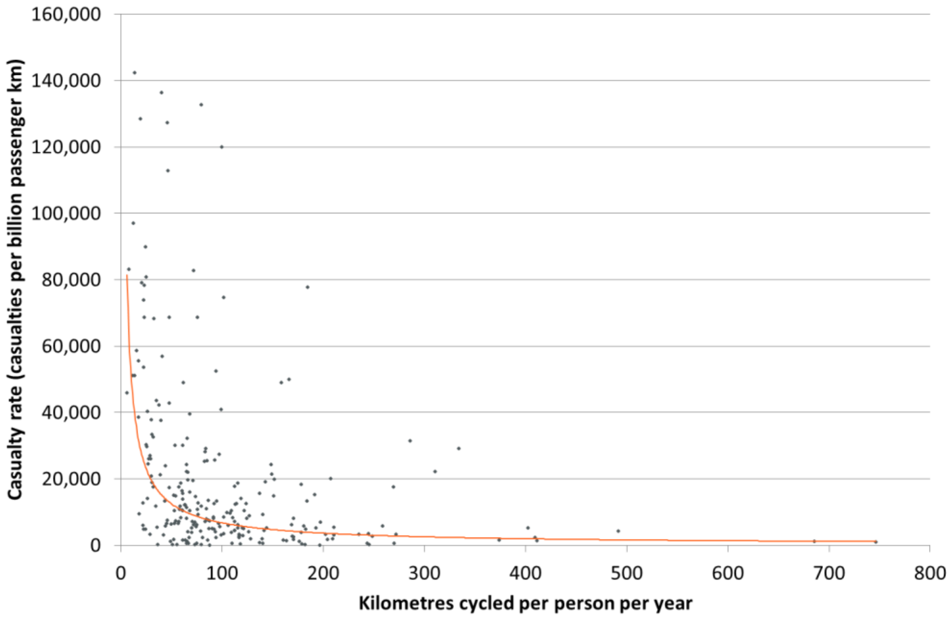

Figure 9: Relationship between cycling casualty rate and kilometres cycled per person per year for different local authorities

Figure 9 shows a similar shape to the chart given in (Ursachi & Owen, 2016) where casualty rate was plotted against cycling per person per year for cities in England. With both figures there will be other differences between cities or local authorities which might account for differences in risk such as the demographics of the population, the type of area and the cycling provision.

Two trend lines were fitted to the data to explore the relationship between kilometres cycled and casualty rate and both showed that casualty rate decreases as cycling per person per year increases. An exponential trend line and a power trend line were both fitted but the power trend line had a larger R^2 value so was chosen to represent the relationship between kilometres cycled and casualty rate in further analysis. The equation of the trend line is:

$$y = 400065x^{-0.886}$$

where y is casualty rate (cycling casualties per billion passenger kilometres) and x is kilometres cycled per person per year. This relationship is used in Section 4.4 to explore the active travel scenarios, having adjusted for SiN.

4.4 Scenario analysis results – safety in numbers approach

The results in Section 4.2 are based on the assumption that the casualty rate for cyclists remains constant across the increase in cycling travel. However, this assumption does not account for any impact of the SiN phenomenon discussed in Section 2.4 and Section 4.3. The analysis in this section takes SiN into account by using the cycling travel figures to estimate cyclist casualty rates for each scenario. This is done using the equation of the trend line from Figure 9 in Section 4.3; further details are given in Appendix A.2. The casualty rates for car occupants and pedestrians are assumed to be constant.

The safety in numbers casualty rates were then used to estimate the number of casualties in each scenario as shown in Table 12 below.

Table 12: Estimated casualty numbers for active travel scenarios (SiN)

Scenario	Car occupants		Pedestrians		Cyclists		Total	
	Casualties	% change	Casualties	% change	Casualties	% change	Casualties	% change
Current (0% uptake)	99,684	-	21,525	-	17,541	-	138,750	-
25% uptake	98,583	-1%	21,712	1%	19,101	9%	139,396	0.5%
50% uptake	97,513	-2%	21,931	2%	20,046	14%	139,490	0.5%
75% uptake	96,443	-3%	22,150	3%	20,735	18%	139,328	0.4%
100% uptake	95,374	-4%	22,368	4%	21,282	21%	139,024	0.2%

The numbers in Table 12 show that when SiN is taken into account, it is estimated there would be an increase of 21% in the number of cyclist casualties in the 100% uptake scenario, when compared to the current (0% uptake) scenario. This is a considerably smaller increase in cyclist casualties than the 473% increase when SiN is not taken into account (see Table 11). The small reduction in car occupant casualties (4%), and 4% increase in pedestrian casualties means that overall there is an estimated 0.2% increase in casualties in the 100% uptake scenario compared with currently.

5 Conclusions

5.1 Summary

This analysis has shown that, on average, 12km per person per year could be walked instead of travelled by car (based on trips which are <1 kilometre in length) and 406km per person per year could be cycled instead of completed in a car (based on trips which are 1-8km in length). These estimates account for factors including mobility issues, age and access to a bicycle, but do not account for characteristics of each trip; for example, the availability of cycle infrastructure or hilliness of the route, which has shown to be an important factor in mode choice, nor the availability of cycling infrastructure.

If all of these car trips were replaced by active travel trips this would represent:

- A 4% increase in walking
- A 473% increase in cycling

However, not all of this active travel is likely to be achievable as this may include some short journeys for which a car may be required, such as shopping for large items, escorting people who are less mobile or journeys that are very hilly. In contrast, there may be other longer journeys which could also be walked or cycled, in particular those which are made up of multiple stages, which have not be considered in this analysis.

This report presents the estimated number of casualties if all of these car journeys were switched to walking or cycling. This was modelled using two assumptions:

1. The casualty rates were assumed to remain constant at the current rates (as a comparator)
2. The pedal cyclist casualty rates were assumed to decline as travel increases, mimicking the effect known as safety in numbers

The results under both assumptions, using a range of uptake scenarios, are presented in Table 13.

Table 13: Casualty estimates for different active travel uptake scenarios

Uptake scenario	Car occupants	Pedestrians	Cyclists		Total casualties	
			Constant casualty rate	SiN accounted for	Constant casualty rate	SiN accounted for
Current (0% uptake)	99,684	21,525	17,541	17,541	138,750	138,750
25% uptake	98,583	21,712	38,276	19,101	158,571	139,396
50% uptake	97,513	21,931	59,013	20,046	178,457	139,490
75% uptake	96,443	22,150	79,749	20,735	198,342	139,328
100% uptake	95,374	22,368	100,485	21,282	218,227	139,024

Figure 10 shows the number of casualties in the current scenario by mode and those estimated in the 50% scenarios. This scenario was selected as an illustration; the other scenarios give a similar overall picture as shown in Table 13.

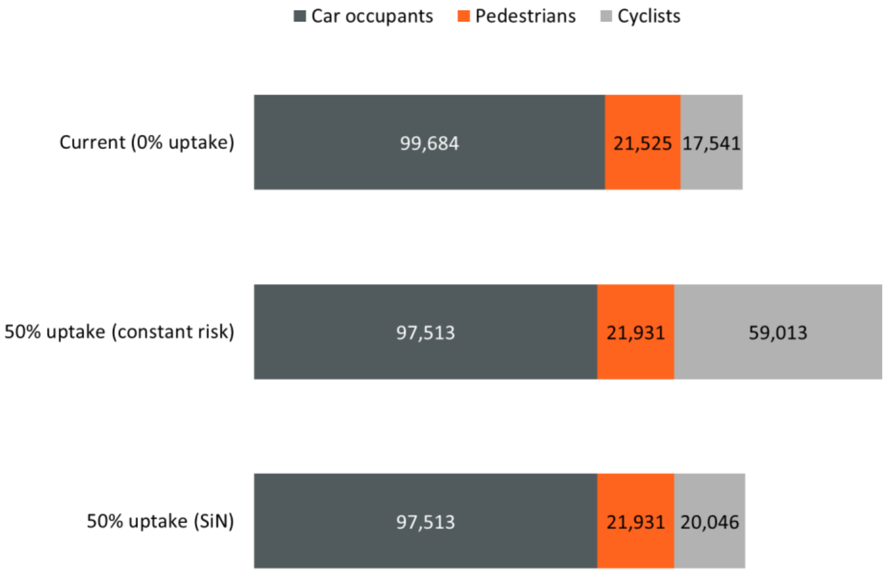

Figure 10: Number of casualties by mode in baseline and 50% uptake scenarios

The estimated increase in cyclist and pedestrian casualties for the active travel constant risk scenario is not surprising, since walking and cycling are known to be higher risk per mile travelled than use of a car. In total, it is estimated there would be an additional 406 pedestrian casualties and 41,472 pedal cyclist casualties if half of the short trips currently carried out by car were replaced with these active travel modes, compared to the current scenario.

In the cycling SiN scenario, it is estimated that there would be a slight increase in cycling casualties (2,505) compared with the current situation. Note that this estimation is based on a modelled relationship between cycling risk and cycle travel which is not necessarily causal; there are other factors not considered which are likely to contribute to different safety levels in different areas. For example, those local authorities which have high levels of cycling and lower cycling risks may also have good cycling infrastructure (this could include cycle-specific facilities such as cycle lanes and provision of bikes, safer cycle routes (e.g. less busy roads) and a higher level of user engagement with the mode). Other factors including driver behaviour, congestion, public transport and weather are also factors that people may take into account when determining their mode choice.

5.2 Discussion

Currently there is no national road safety target but many road authorities are setting targets for casualty reduction. Authorities may also have targets to increase the amount of active travel. The analysis in this report has shown that increasing the active travel may also increase the casualties and therefore progress towards both of these goals could be challenging. In order to maintain (or reduce) casualties from current levels, road authorities may need to implement road safety interventions (particularly for VRUs) to offset the expected increase in casualties expected if travel using active modes increases. These interventions may include infrastructure adaptations (e.g. footpaths, cycle paths, safe crossing points, road surfaces, street lighting and cycle parking provision) and/or education initiatives (e.g. cyclist training, training for car drivers on safety around pedal cyclists).

Although the SiN estimate shows a smaller increase in cyclist casualties than the current risk scenario, given the uncertainty in the magnitude or reasons for the safety in numbers effect, this should not be relied upon to reduce the cycling casualty risk alone. Additional measures are likely to be required that would help to both increase the amount of cycling and reduce the risk to cyclists; for example, cycle infrastructure and engaging with drivers, cyclists and potential cyclists. Some of the effect of SiN may be due to drivers having a higher expectation of seeing cyclists, and also a greater proportion of drivers also being cyclists and therefore changing their behaviour.

In the 2015 British Social Attitudes survey, 59% of survey respondents agreed with the statement ‘it is too dangerous for me to cycle on the roads’. This suggests that in addition to implementation of road safety interventions to reduce cycling risk, those responsible for road safety should also focus on reducing the perceived risk of cycling.

5.3 Limitations/potential improvements to model

There are several improvements that could be made to the methodology to improve the robustness and relevance of the results.

The estimates in this report give the increase in road casualties estimated for an increase in active travel. There are other benefits not accounted for here such as health benefits, which have been shown to outweigh this casualty increase by an estimated 20:1 (CyclingUK, 2017). These benefits could be included to give the overall health benefit of active travel.

The estimates in this report do not account for any underlying trends in casualty rates or other changes in exposure, such as population growth or traffic growth. This means that the casualty estimates cannot be used to forecast into the future. This could be included in a future model.

The Propensity to Cycle Tool (see Appendix B) suggests that in addition to the trip distance, the hilliness of the route is also an important factor in mode choice – this was not accounted for in this study and could possibly be incorporated into a more detailed model (e.g. to refine the criteria for potential cycling journeys).

Several criteria were used to select trips from NTS that had the potential to be travelled more actively. It is unlikely that all of those trips identified could be cycled; for instance, shopping for large items, escorting others with mobility difficulties or trips in the dark or poor weather. Note that TfL’s analysis of cycling potential (Transport for London, 2017) did not include mobility difficulties as a filter stating that ‘disability should not be a barrier to cycling’. Access to a bicycle was also not included as part of TfL’s criteria. Removing this filter from this work would almost double the potential number of cycle trips.

6 Next steps

This section identifies further work that would improve understanding in this area.

6.1 Account for other benefits of active travel and convert benefits to economic values

The work presented in this paper estimates the change in total casualties if a number of active travel scenarios were adopted, but the analysis could be adapted to estimate the differences in casualty numbers by injury severity, specifically the changes in fatal and seriously injured casualties. Since cyclists and pedestrians are more vulnerable and have higher severity than car occupants in collisions these severities would be expected to show greater percentage differences in the increased active travel uptake scenarios compared with the current baseline. Using the value of prevention of casualties for each injury severity (DfT, 2017d), the increased economic burden for these scenarios could then be modelled.

Whilst the work presented in this report focusses on the casualty impact of increasing active travel, there are likely to be benefits of these active travel scenarios which have not been considered in this analysis. For example, increased active travel is likely to result in:

- Improved health
- Improved air quality
- Reduced congestion

The health benefits of active travel can be calculated using WHO's Health Economic Assessment Tool (HEAT). This tool estimates the economic value of the health benefits of current levels of cycling and walking, to assess changes over time and to evaluate projects.

The quantifiable value of prevention of these casualties and the quantifiable health benefit could then be combined with an estimated cost of a proposed scheme to calculate the benefit cost ratio (BCR). This would enable policy makers and road safety engineers to evaluate whether there is a net economic gain in implementing an active travel policy or scheme.

6.2 Understand more on who and where has the most potential for active travel

The London Travel Demand Survey (or LTDS, which is equivalent to the NTS but only for London) has been used by TfL to analyse the characteristics of people undertaking short journeys by car which could be switched to walking and cycling. The aim of this work was to understand the demographic profile of active travel users currently and those who could potentially switch to active travel modes so that measures such as user engagement through publicity or education can be targeted.

In addition to the demographic profile, TfL has also analysed the characteristics of the journeys, in terms of the start and end points of the routes, in order to review cycling and walking provision at these locations.

We could make a tool for local authorities that uses the NTS data or the 2011 census data to show demographics and locations of short journeys, which could be used to understand more on where and who makes journeys that could be switched to active travel or where measures to encourage cycling or walking should be targeted and what demographics they should be aimed at. This data or tool would ensure that cycle or infrastructure or engagement with potential active travellers was targeted appropriately.

6.3 Geographical analysis

There are likely to be different patterns in different geographies; for example, in rural and urban areas and in areas which have greater levels of cycling infrastructure. More detailed analysis could include the potential for cycling in different regions and the associated change in casualties. This could be made into a tool to enable local authorities to investigate the potential for cycling in an area based on the NTS data, in a similar way to the Propensity to Cycle tool, and also gives the estimated change in casualties for various active travel scenarios.

7 References

Bauman, A., Rissel, C., Garrard, J., Ker, I., Speidel, R., & Fishman, E. (2008). *Cycling: getting Australia moving- barriers, facilitators and interventions to get more Australians physically active through cycling.* New South Wales, Australia: Australasian Transport Research Forum.

Beckx, C., Broekx, S., Degraeuwe, B., Beusen, B., & Panis, L. (2013). Limits to active transport substitution of short car trips. *Transportation Research Part D: Transport and Environment*, 10-13.

Blaizot, S., Papon, F., Haddak, M., & Amoros, E. (2013). Injury incidence rates of cyclists compared to pedestrians, car occupants and powered two-wheeler riders, using a medical registry and mobility data, Rhône County, France. *Accident Analysis & Prevention*, 35-45.

CyclingUK. (2017). *Health and cycling*. Retrieved from CyclingUK.org: https://www.cyclinguk.org/campaigning/views-and-briefings/health-and-cycling

DfT. (2016a). *National Travel Survey.* Retrieved from Gov.uk: https://www.gov.uk/government/statistics/national-travel-survey-2016

DfT. (2016b). *Passenger casualty rates for different modes of travel (RAS53).* Retrieved from Gov.uk: https://www.gov.uk/government/statistical-data-sets/ras53-modal-comparisons

DfT. (2017a). *British social attitudes survey (ATT03).* Retrieved from Gov.uk: https://www.gov.uk/government/statistical-data-sets/att03-attitudes-and-behaviour-towards-roads-and-road-travel

DfT. (2017b). *Casualties involved in reported road accidents (RAS30).* Retrieved from Gov.uk: https://www.gov.uk/government/statistical-data-sets/ras30-reported-casualties-in-road-accidents

DfT. (2017c). *National Travel Survey, 2002-2016. [data collection]. 12th Edition. UK Data Service. SN: 5340,*. Retrieved from http://doi.org/10.5255/UKDA-SN-5340-8

DfT. (2017d). *Accident and casualty costs (RAS60).* Retrieved from Gov.uk: https://www.gov.uk/government/statistical-data-sets/ras60-average-value-of-preventing-road-accidents

DfT. (2017d). *Reported road casualties Great Britain: 2016 Annual report.* Retrieved from Gov.uk: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attac hment_data/file/668504/reported-road-casualties-great-britain-2016-complete-report.pdf

DfT. (2017e). *Reported road casualties in Great Britain: 2016 annual report.* Retrieved from Gov.uk: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/648081/rrcgb2016-01.pdf

DfT. (2018). *Walking and Cycling Statistics, England: 2016.* Retrieved from Gov.uk: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/674503/walking-and-cycling-statistics-england-2016.pdf

Elvik, R. (2016). Safety-in-numbers: Estimates based on a sample of pedestrian crossings in Norway. *Accident Analysis & Prevention*, 175-182.

Elvik, R. (2017). Exploring factors influencing the strength of the safety-in-numbers effect. *Accident Analysis & Prevention*, 75-84.

Elvik, R., Sørensen, M. W., & Nævestad, T. (2013). Factors influencing safety in a sample of marked pedestrian crossings selected for safety inspections in the city of Oslo. *Accident Analysis & Prevention*, 64-70.

Fairnie, G., Wilby, D., & Saunders, L. (2016). Active travel in London: The role of travel survey data in describing population physical activity. *Journal of Transport & Health*, 161-172.

Fishman, E., Washington, S., & Haworth, N. (2015). Bikeshare's impact on active travel: Evidence from the United States, Great Britain, and Australia. *Journal of Transport & Health*, 135-142.

Fowler, S., Berrigan, D., & Pollack, K. (2017). Perceived barriers to bicycling in an urban U.S. environment. *Journal of Transport & Health*, 474-480.

Hérick, T., Parra, D., & Monteiro, C. (2015). Impact of travel mode shift and trip distance on active and non-active transportation in the São Paulo Metropolitan Area in Brazil. *Preventive Medicine Reportsq*, 183-188.

Jacobsen, L. P. (2004). Safety in numbers: more walkers and bicyclists, safer walking and bicycling. *Injury Prevention*, 127-127.

Johnson, M., Oxley, J., Newstead, S., & Chariton, J. (2014). Safety in numbers? Investigating Australian driver behaviour, knowledge and attitudes towards cyclists. *Accident Analysis & Prevention*, 148-154.

Jones, T. (2012). Getting the British back on bicycles- the effects of urban traffic-free paths on everyday cycling. *Transport Policy*, 138-149.

Kaplan, S., & Prato, C. (2015). *Spatial Analysis of Land Use and Network Effects on Frequency and Severity of Cyclist-Motorist Crashes in Copenhagen Region, Denmark.* Washington DC: Transportation Research Board.

Knowles, J., Adams, S., Cuerden, R., Savill, T., Reid, S., & Tight, M. (2009). *Collisions involving pedal cyclists on Britain's roads: establishing the causes. TRL PPR445.* Wokingham: TRL.

Kröyer, H. (2016). Accidents between pedestrians, bicyclists and motorized vehicles: accident risk and injury severity. *Safety Science*, 315-324.

Lovelace, R., Goodman, A., Aldred, R., Berkoff, N., Abbas, A., & Woodcock, J. (2017). *The Propensity to Cycle Tool: An open source online system for sustainable transport planning.* Retrieved from https://www.jtlu.org/index.php/jtlu/article/view/862

Marqués, R., & Hernández-Herrador, V. (2017). On the effect of networks of cycle-tracks on the risk of cycling. The case of Seville. *Accident Analysis & Prevention*, 181-190.

Osama, A., & Sayed, T. (2016). Evaluating the impact of bike network indicators on cyclist safety using macro-level collision prediction models. *Accident Analysis & Prevention*, 28-37.

Propensity to Cycle Tool. (n.d.). Retrieved from http://pct.bike/)

Public Health England. (2016). *Working together to promote active travel. A briefing for local authorities.* Retrieved from gov.uk: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/523460/Working_Together_to_Promote_Active_Travel_A_briefing_for_local_authorities.pdf

Road Safety Analysis Limited. (2016). *Safety in Numbers for Cyclists in England: Measuring the Effect.* London: RSA.

Schepers, J. P., & Heinen, E. (2013). How does a modal shift from short car trips to cycling affect road safety? *Accident Analysis & Prevention*, 1118-1127.

TfL. (2010). *Analysis of cycling potential.* Retrieved from tfl.gov.uk: http://content.tfl.gov.uk/analysis-of-cycling-potential.pdf

Thompson, J., Savina, G., & Stevenson, M. (2016). Reconsidering the Safety in Numbers Effect for Vulnerable Road Users: An Application of Agent-Based Modeling. *Traffic Injury Prevention*, 147-153.

Thompson, J., Wijnands, J., Savino, G., Lawrence, B., & Stevenson, M. (2017). Estimating the Safety Benefit of Separated Cycling Infrastructure Adjusted for Behavioral Adaptation among Drivers; An Application of Agent-Based Modelling. *Transportation Research Part F: Traffic Psychology and Behaviour*, 18-28.

Transport for London. (2016). *Analysis of Cycling Potential .* London: Transport for London.

Transport for London. (2017). *Analysis of cycling potential 2016.* Retrieved May 2017, from tfl.gov.uk: http://content.tfl.gov.uk/analysis-of-cycling-potential-2016.pdf

Ursachi, U., & Owen, R. (2016). *Safety in Numbers of cyclists in England: Measuring the Effect.* Retrieved May 2017, from Road Safety Analysis: http://www.roadsafetyanalysis.org/wp-content/uploads/sites/17/2016/11/Cycling-Safety-In-Numbers-England-Initial-Findings-v1.2.pdf

Appendix A Additional data

This appendix gives the data sources and calculations used to give the casualty rates for England (A.1) and details of the methodology used to estimate the safety in numbers casualty rates (A.2).

A.1 GB and England casualty rates by mode

A.1.1 Walking casualty rate in England and Great Britain

The number of pedestrian casualties in England (from Stats19), the average distance travelled per person per year (from NTS) and the mid-year population estimate (from the Office for National Statistics[5]) were used to estimate the pedestrian casualty rate for England using the following formula:

$$Pedestrian\ casualty\ rate = \frac{Pedestrian\ casualties}{(Miles\ walked\ per\ person\ \times population\ estimate)}$$

The results from this calculation, and a comparison to the published GB figures, is shown in Table 14.

Table 14: Casualty, travelling and risk for pedestrians, England and GB, 2015

	England	GB
Pedestrian casualties (RAS30034)	21,525	24,061
Miles walked per person per year (NTS0305)	184	-
Mid-year population estimate (MYE4)	54,786,300	63,258,400
Walking in billion passenger km	16.1	18.7 (calculated from published rate)
Pedestrian casualty rate (per billion passenger km)	1,335	1,290 (from RAS530001)

This shows that 89% of pedestrian casualties in GB were in England. The risk level for England was 3% higher than for GB as a whole (1,335 compared to 1,290); suggesting that the number of pedestrian casualties per mile travelled is higher in England than that in Scotland and Wales.

5 https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/datasets/populationestimatesforukenglandandwalesscotlandandnorthernireland

A.1.2 Cycling casualty rate in England and Great Britain

The number of casualties (from Stats 19) was used together with data showing the total distance travelled by bicycle (from DfT traffic data[6]) to estimate the rates for cycling in England. Table 15 shows these figures, along with a comparison to the rate for GB.

Table 15: Casualty, travelling and risk for cycling, England and GB, 2015

	England	GB
Casualties (RAS30034)	17,541	18,844
Billions vehicle-km cycled (TRA0413)	4.70	5.23
Pedal cyclist casualty rate (per billion passenger km)	3,732	3,603[7]

This shows that 90% of cyclist casualties and 93% of distance travelled in GB were in England. As with the pedestrian casualty rate, the pedal cyclist casualty rate for England is 4% higher than for GB.

A.1.3 Car travel casualty rate in England and Great Britain

Table 16 shows the number of car occupant casualties[8] in England (from Stats19), estimates of the distance travelled by car (from DfT traffic data), average car/van occupancy data[9] (from NTS) and the corresponding car occupant casualty rates per billion passenger kilometres calculated using:

$$Car\ occupant\ casualty\ rate = \frac{Car\ occupant\ casualties}{(Car\ traffic\ \times\ Average\ occupancy)}$$

These calculated results for England are compared to the car occupant casualty rate for GB.

[6] https://www.dft.gov.uk/traffic-counts/

[7] Rate given as 3,618 in RAS530001).

[8] Note that this includes taxi and minibus occupant casualties.

[9] Note this does not include taxi occupancy.

Table 16: Casualty, travelling and risk for car occupants, England and GB, 2015

	England	GB
Car occupant casualties (RAS30034)	99,684	111,707
Car traffic in billion vehicle km (TRA0206)	341.5	398.6
Average car/van occupancy	1.56 (from NTS0905)	1.65
Car travel in billion passenger km[10]	532.9	657.1
Car occupant casualty rate (per billion passenger km)	187.1	170 (from RAS530001)

A.2 Safety in numbers casualty rates

The total distance cycled in England in 2015 was 4.7 billion passenger kilometres (Table 15) and this is equivalent to 85.2km per person (0% uptake scenario).

The actual casualty rate for the 0% uptake scenario (Table 9) is higher than the casualty rate estimated using the trend line equation from Figure 9. Therefore, the casualty rates calculated from the trend line were adjusted so that they were relative to the actual 0% uptake scenario casualty rate. The expected casualty rates for the different uptake scenarios were then calculated based on the travel estimate for each scenario (Table 10).

Table 17: Calculated and adjusted cycling casualty rates (casualties per billion passenger kilometres)

Scenario	Cycling casualty rate from trend line equation	Percentage decrease from 0% uptake scenario	Adjusted casualty rate
0% uptake	7,794	0%	3,732[11]
25% uptake	4,702	40%	2,252
75% uptake	2,701	65%	1,294
100% uptake	2,244	71%	1,075

Table 17 shows the estimated casualty rates based on the trend line equation from Figure 9 for the 0%, 25%, 75% and 100% uptake scenarios. Also shown in Table 17 is the percentage decrease in casualty rate for each scenario compared to the 0% uptake scenario and the adjusted casualty rates based on the actual 0% uptake scenario casualty rate.

[10] This assumes the average car/van occupancy data applies also to cars.

[11] This is the actual 0% uptake scenario cycling casualty rate from Table 10.

Appendix B Propensity to cycle tool

A propensity to cycle tool has been developed for England and Wales (Lovelace, et al., 2017) which shows the current level of cycling geographically and various future scenarios based on statistical modelling. Figure 11 shows the levels of cycling to work from the 2011 census. This helps to understand the current levels of cycling and what geographical areas have potential for increasing the amount of cycling to work.

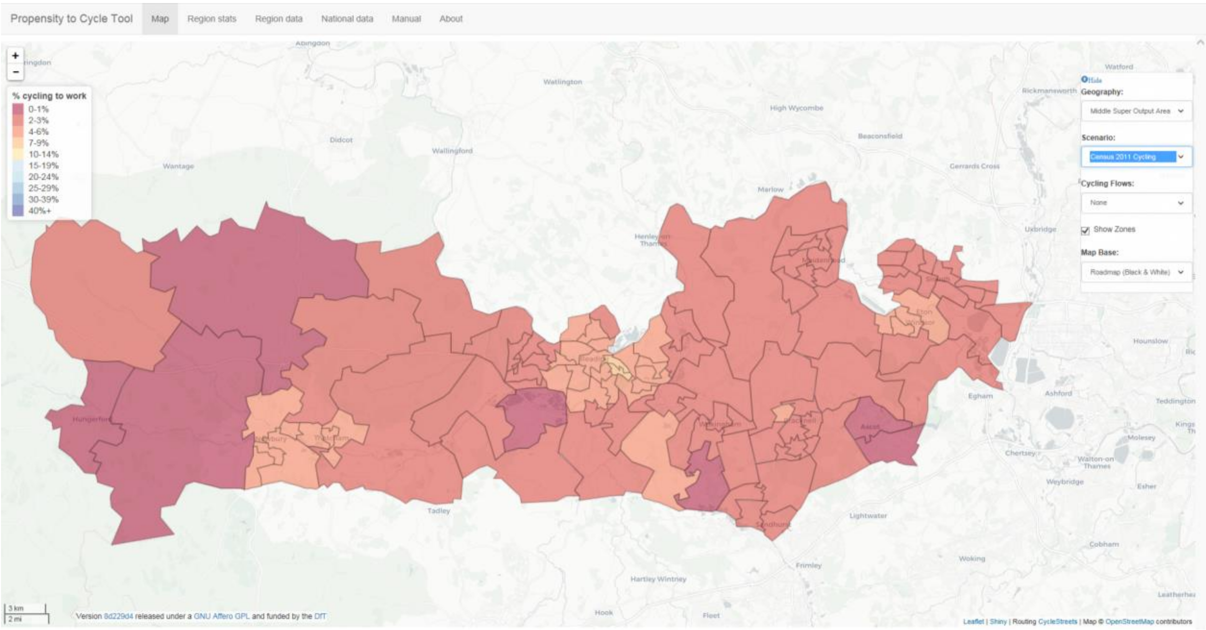

Figure 11: Cycling levels in Berkshire (Propensity to Cycle Tool)

A statistical model was used to relate the baseline levels of cycling to the distance to work and the hilliness of the route, and the propensity to cycle was estimated for the following scenarios:

- Government target:
    - This models a doubling of cycling nationally. This is achieved by larger increases in areas with many short, flat routes and below average current levels. Conversely, areas with above average levels or cycling and many long distance hilly routes have smaller increases.
- Go Dutch:
    - This model estimates what would occur if English and Welsh people were as likely as Dutch people to cycle a trip of a given distance and hilliness.
- E-bike:
    - This models the increase in cycling if there was widespread uptake of e-bikes which gives an increased willingness to cycle on longer or hillier routes.
- Gender equality:
    - This model increases the cycling by females to match that of males.

Geographical analysis is possible at census Lower Output Area (LOA) and route origin and destinations can also be displayed on the map.

The modelled estimates were also used to estimate the physical health benefits using WHO's Health Economic Assessment Tool (HEAT) and reductions in CO2 emissions from the reduction in car driving.

Healthy mobility and road safety

This report presents the findings of analysis using National Travel Survey and STATS19 data to explore the possible implications of increased active travel on the number of casualties and casualty rates for pedestrians and pedal cyclists. The analysis includes an estimate of safety in numbers for cyclists.

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