CYCLING

RoSPA POLICY PAPER

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CONTENTS AND STRUCTURE

Executive Summary

This policy paper has been produced to support the GB governments' visions of making walking and cycling the natural choice for shorter journeys. RoSPA strongly supports measurers which encourages healthy and sustainable travel. This policy paper consider the health benefits of cycling versus the risks associated with it and the primary and secondary safety measures can be put in place so that a rise in the numbers of people cycling does not automatically mean a corresponding increase in cyclist casualties.

There is strong evidence[1,2,3] that cycling provides a wide range of health benefits which reduces the risk of dying prematurely from many causes. Cycling is a convenient and affordable form of physical activity which can be easily integrated in to daily life. Regular exercise can reduce heart disease, blood pressure and the risk of developing cancers such as colon and breast cancer. Exercise can help to maintain a healthy weight, reduce depression and promote psychological well-being.

However, cycling also involves risk. Between 2011 and 2013, there were on average 19,248 cycle casualties per year, of which 80% were male. Most cyclist casualties are adults. Accidents involving child cyclists are often the result of the child playing, doing tricks, riding too fast or losing control. For teenage and adult cyclists, accidents are more likely to involve collisions with motor vehicles, but about 16% of their fatal or serious cyclist accidents reported to the police do not involve a collision with another vehicle, but are caused by the rider losing control of their bicycle. Around 75% of fatal or serious cyclist accidents occur in urban areas, at or near a road junction. In collisions involving a bicycle and another vehicle the most common contributory factor attributed to the driver is failed to look properly. HGV present a particular danger to cyclists, especially in relation to left turning vehicles. In London for example, around 20% of cyclist fatalities involve an HGV. The severity of injuries sustained by cyclists' increases with the speed limit.

The paper examines evidence from within the UK and abroad and is divided in to two main sections: engineering and road user behaviour. The advantage of a 'safe system model' is considered where vehicle speeds are reduced so that collisions on the road are much less likely to occur, and those that do occur are at a speed unlikely to cause fatal injury. Evidence from Portsmouth and Bristol is considered in relation to the adoption of 20mph limits. In Portsmouth, a 20mph limit was introduced on around 94% of roads that previously had a 30mph limit Traffic speed was monitored before and after the introduction on 223 sites to establish effectiveness. There was an overall average speed reduction of 1.3mph following the introduction of the limits, as the average speed dropped from 19.8mph to 18.5mph. The change in speeds varied from a reduction of 0.6mph to 1.7mph, and across the city this was a statistically significant reduction.

Bristol has also piloted 20mph limits in two areas. Two years after the introduction of the lower limits, speed surveys on 10% of the roads covered by the scheme found a reduction in mean daytime speeds on 65% of the roads. On residential roads, there was on average a 0.4mph reduction in traffic speeds. There was a greater reduction on main roads, as 1.7mph was the average reduction in the Inner East area and 1.3mph in the Inner South area. The report also considers the impact that spatial planning and the National Planning Policy Framework can have on developing a cycle friendly environment.

With over 90% of crashes involving human error the policy paper looks at how road user behaviour (both drivers and cyclists) can be improved through education and training. The use of cycle helmets, lights and high visibility clothing is also discussed.

Lorries present a particular danger to cyclists when the two are involved in a collision. Cyclists are less likely to be involved in a collision with a HGV than a car but when they are, they are more likely to be killed or seriously injured. Between 2009 and 2013 they were involved in 23% of deaths despite comprising only 5% of the traffic. Cars, in comparison, account for 78% of traffic, but only account for 58% of cyclist fatalities. The report considers how lorry design, technological aids and the management of HGV can influence cyclist safety.

The report looks at the evidence in to the relationship between traffic volume and casualties and concludes that it is not inevitable that more cycling will lead to more cycling accidents. One study found that slightly more walking and cycling accompanied by the same decrease in car use was broadly safety neutral, but that a large shift from driving to walking or cycling could reduce accidents. Another suggested that replacing 10% of car trips shorter than 7.5 km by bicycle would be safety neutral.

The recommendations from this policy paper are:

Cycling should be promoted.

Government, Local Authority and other cycling strategies and action plans should be supported.

The health benefits of cycling should be considered alongside the risks involved.

To facilitate the growth in cycling, while minimising the risk that this will result in increased cyclist casualties, a comprehensive range of measures should be introduced, including:

Engineering

- New cycle infrastructure to be designed in accordance with the principles of the ‘SAFE STSTEM approach.
- Reduced speed limits should be considered where there is substantial cycling and pedestrian activity, or the potential for such activity. This includes the majority of built-up streets. On roads with higher speed limts, or higher traffic volumes, protected cycling facilities should be provided.
- The design and construction of cycle facilities should follow best practice from home and abroad as fully as possible.
- Wherever practical, new cycle lanes should be planned to be continuous and to give priority to cyclists at junctions. They should be of sufficient length to provide meaningful separation from traffic.
- Further research should be conducted to identify how best to provide for cyclists at junctions.
- The transport system must be balanced in favour of sustainable transport modes.
- The provision of cycling policies and facilities should complement those for pedestrians.
- Highway Authorities should consider the safety of, and improved provision for, cyclists as an integral part of their cyclical maintenance programmes (winter maintenance, vegetation cutting, surfacing, etc)
- Highway authorities should consider the safety implications, especially for cyclists and pedestrians, as well as the environmental and financial benefits when considering whether or not to switch off or reduce the level of street lighting.

Education and Training

- Practical theory and on road training for both drivers and cyclists must highlight the danger of:
    - Large vehicle collisions, especially resulting from left turn manoeuvres
    - The importance of looking out for cyclists at junctions
    - Collisions resulting from failure to look properly, frontal collision crashes, and failure to judge other persons path or speed
    - Cyclist entering the road from the pavement, including when a cyclist crosses the road at a pedestrian crossing
    - The importance of safe overtaking
- How to interact and share space with cyclists safely should be actively included in learner driver training, refresher professional driver training and driver diversionary training courses. Drivers should understand cyclist road positioning, and the reasons for it, as taught in the cyclist training.
- The use of cycle helmets, lights, reflectors and high visibility garment should be encouraged as a secondary safety feature but should not be compulsory (other than the mandatory use of cycle lights and reflectors as currently required by law).
- Research into the effectiveness of cycle lights, reflectors and high-visibility garments should be conducted.
- Practical cyclist training for teenagers and adults, as well as for children,

should be provided and promoted. In particular, the marketing of teenager and adult cyclist training should emphasise the reasons for, and benefits of, taking practical cyclist training.

Enforcement

- Locally targeted traffic enforcement should be undertaken where motorists have been identified to be causing danger and intimidation to cyclists and other vulnerable road users.
- Locally targeted and proportionate traffic enforcement should be undertaken where cyclists are seen putting themselves or other road users in danger.
- The regulations and standards that govern cycle lights should be reviewed and updated where appropriate to reflect technological advancements and improvements in cycle lighting.

INTRODUCTION

Purpose of this Policy Paper

This policy paper has three main objectives:

1. To review and summarise information on the benefits and risks of cycling in Great Britain

2. To identify the best ways of meeting the challenge of increasing cycling without also increasing cyclist casualties.

3. To produce evidence and recommendations that will assist RoSPA and other organisations to tackle this challenge.

Although this policy paper focuses on cycling, many of the principle discussed also apply to walking. Both are important and valuable forms of physical activity and transport, which should be accorded equal priority in terms of public policy. Many of the health benefits gained from cycling can also be gained from walking, and many of the measures to improve cycling safety, for example, speed management, also improve walking safety. However, they are two very different modes, and mixing them together inappropriately can cause fear, anxiety, insecurity and even serious injury.

Policies and infrastructure to promote cycling, and improve cycling safety, should not be made in isolation. Both pedestrians and cyclists are highly vulnerable to, and restricted by, motor traffic. It is important to recognise that both are vulnerable road users, and aim to reduce the risk of collisions, and produce an environment that both pedestrians and cyclists feel safe using, as well as to improve driver behaviour.

Levels of Cycling

Over much of the 20th century, the level of cycling in Great Britain fell substantially, at the same time as levels of motor vehicle traffic increased massively. However, recent years have seen an upsurge in cycling (although levels vary across the country), which has been supported by a significant increase in investment in promoting cycling and providing a safer cycling environment.

The average distance travelled by bicycle increased by 8% from 46 miles per person per year in 1995/97 to 49 miles in 2013. The average distance travelled by bike by London residents has increased by 55% since 1995/7.[4]

In 2012/13, 15% of adults in England cycled at least once a month, 10% cycled at least once a week and 3% cycled at least five times a week. Cycling varies across the country with higher levels in the East, East Midlands, and parts of the South East; and lower levels in the North East. The areas with the highest levels of cycling (at least once a week) were Cambridge (49%), Oxford (34%), Richmond upon Thames (21%), Hammersmith and Fulham (19%), and Boston (18%). The average for England was 10%.[5]

For the majority of local authorities in the period, there was no significant change. There were significant increases in cycling in East Sussex, two London Boroughs, and ten other authorities, but significant declines in six counties, four London Boroughs, and 29 other authorities.

In London, there has been a 150% increase in cycling levels between 2000 and 2010 and there has been an increase in cycling as a spectator sport nationally following the Olympics and the Tour de France grand depart from Yorkshire in 2014 and this may encourage more people to start cycling in the future.

Currently, more people cycle for recreational purposes than for utility purposes (eg, commuting or shopping). 10% of people cycle recreationally at least once per month, and 7% cycle for utility purposes. 2.8% of people cycled to work. Men (3.9%) are more likely to cycle to work than women (1.6%). Women account for about half of occasional (once a month) cyclists, but smaller proportions of more frequent cyclists. On average, at all ages, lower proportions of women tend to cycle for all purposes than men.

The peak age ranges for adults cycling is 16 to 24 and 35-44 years, for both genders.

In England as a whole, the prevalence of cycling at least once per month in the year ending mid-October 2013 has reduced slightly from the previous year, from 15.3% to 14.7%.

Over the three years of the Active People Survey (APS), the pattern of cycling levels in England has varied. For about two thirds of authorities, the pattern has been mixed, increasing and declining, cycling increased consistently in 13% of authorities, but declined consistently in 20% of authorities. There is some indication that those authorities with higher levels of cycling also saw higher increases in cycling in the last year.

Use of the National Cycle Network (NCN) in Scotland rose by 44% between 2008 and 2010, with 40.7 million trips being made on it in 2010.[6] Over 35% of those trips were made by commuters, using the growing network of paths and short links to get to work by bike, up from just 3.7% in 2008. In June 2012, Sustrans reported a further increase of 19% cycle trips on the NCN in Scotland during 2011.

In Scotland, the overall number of primary school children cycling to school in 2011 was 4.0% compared to 3.7% in 2010. The number of secondary school children cycling to school increased slightly to 1.3% in 2011 from 1.2% in 2010.[7]

In Wales, data from the 2014 Travel Survey showed that for people aged 16 and over reporting on their travel over the previous 3 months, 6% travelled by cycle for active travel trips at least once a week. Of these journeys going to the shops, going to work and visiting friends were the main trip generators.[8]

Comparisons with Other Countries

Across Europe many governments and cyclists have similar aspirations as the UK to increase the level of cycling without compromising safety. For example, the European Cycling Federation (ECF) and signatory cities of the Charter of Brussels ask the EU to set a target of at least 15% of the share of cycling in the modal share in trips in Europe by 2020, together with a set of measures to halve injury and fatality rates for cyclists between 2010 and 2020.

Comparing European data with the UK is difficult due to the different ways data is collected. For example, the UK is only one of three EU countries, together with Denmark and the Netherlands, to measure cycle use at the national level on an annual basis. Sweden and Norway also collect data on a regular basis. Using this data the European Transport Safety Council (ETSC) compared cycle use and cycle safety in these 5 countries, producing the following table which shows the number of cyclist deaths per billion kilometres ridden.

Country	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Av. For last 3 years	Km cycled per person
Norway	11.5	n/a	n/a	n/a	10.1	n/a	n/a	n/a	11.0	n/a	11.0	171.1
Denmark	19.6	17.2	15.8	18.8	13.6	10.4	18.8	17.8	8.5	9.9	12.1	521.3
Netherlands	17.3	15.1	15.9	13.1	12.7	15.4	13.4	13.2	12.3	11.6	12.4	863.2
Sweden	n/a	n/a	n/a	n/a	n/a	14.4	n/a	n/a	n/a	n/a	14.4	198.9
UK	33.1	30.2	25.7	32.4	34.3	31.7	32.5	24.2	21.0	22.1	22.4	79.7

When looking at national data it is important to be mindful of local variations. For example, London has 1.7 pedal cycle fatalities per million population compared to Oslo and Amsterdam which have 6.5

The Benefits and Risks of Cycling

The Benefits of Cycling

There is strong evidence[9,10,11] that cycling provides a wide range of health benefits, mainly because it is convenient and affordable form of physical activity, and increasing physical activity reduces the risk of many forms of ill-health and disease.

Cycling can easily be incorporated into daily life – by cycling to work, school, to see friends or to the shops. It is estimated that from 1961-2005 that there was a 20% reduction in physical activity within the country, which is predicted to rise to 35% by 2030. More than 4 in 10 people currently do not carry out enough physical activity to achieve good health and this has significant negative impact upon their lives. An All Party Commission on Physical Activity report[12] estimates that physical inactivity leads to 37,000 premature deaths in England.

Lack of physical activity is one of the most important risk factors for coronary heart disease, with a physically inactive lifestyle doubling the risk compared to an active lifestyle. Regular exercise is central to improving the nation's health, with cycling being an excellent method of building regular exercise in to people's daily lives.

In summary, regular physical activity:

- Reduces the risk of dying prematurely
- Reduces the risk of dying prematurely from heart disease
- Reduces the risk of developing diabetes
- Reduces the risk of developing high blood pressure
- Helps reduce blood pressure in people who already have high blood pressure
- Reduces the risk of developing colon and breast cancer
- Reduces feelings of depression and anxiety
- Helps control weight
- Helps build and maintain healthy bones, muscles and joints
- Helps older adults become stronger and better able to move about without falling
- Promotes psychological well-being.

In addition to the health benefits, there are also environmental benefits to cycling rather than driving, as cycles generate directly no CO2.

The Department for Transport estimates that it's possible to achieve a 60% CO2 reduction in the UK's domestic transport sector by 2030, but only with real and early change in travel behaviour. At the moment there is one car for every two people in the UK, and CO2 emissions from cars make up 13% of the UK total. Car Travel is the single biggest source of household and individual CO2 emissions in the UK. If all drivers reduced their driving by 5 miles a week 2.7 million tonnes of CO2 could be saved per annum.[13]

The Risks of Cycling

Unfortunately, despite the health benefits, cyclists are also at risk of injury. Every year in Britain around 19,000 cyclists are killed or injured in police reported road accidents, including around 3,000 who are killed or seriously injured.

Reported Cyclist Casualties and Rate per billion vehicle miles, Great Britain, 2003 - 2013[14]

	Killed	**KSI**	**All**	**Fatality Rate**
2003	114	2,411	17,033	41
2004	134	2,308	16,648	52
2005	148	2,360	16,561	55
2006	146	2,442	16,196	52
2007	136	2,564	16,195	53
2008	115	2,565	16,297	40
2009	104	2,710	17,064	35
2010	111	2,771	17,185	37
2011	107	3,192	19,215	35
2012	118	3340	19,091	38
2013	109	3252	19,438	34

These are casualties that have been reported to the police. However, studies have shown that reporting rates for pedal cyclist casualties tend to be lower than for other road users. Pedal cyclist non fatal data casualties are amongst the most likely to be under reported in data collected by the police, especially when the cycle was the only vehicle involved. Based on hospital data (Hospital Episode Statistics) the number of cyclist admissions is more than three times the number of seriously injured casualties in accidents recorded by the police.[15]

It is questionable whether the recent rise in cyclist casualties is due to the roads becoming more dangerous or to more people cycling. Traffic counts and the National Travel Survey suggests that cycling levels are around 13% or 20% higher than the 2005-9 average depending on the data collection method employed.

Most cyclist casualties are adults. Accidents involving child cyclists are often the result of the child playing, doing tricks, riding too fast or losing control. For teenage and adult cyclists, accidents are more likely to involve collisions with motor vehicles, but about 16% of their fatal or serious cyclist accidents reported to the police do not involve a collision with another vehicle, but are caused by the rider losing control of their bicycle.

Cyclist casualties by age 2013

	Child (0-15)	Adult (16-59)	Adult (+60)
Killed	6	78	25
Serious	276	2,531	281
Slight	1,676	13,344	830
Total	1,958	15,953	1,136

For males, young cyclists in their teens and 20's have the highest numbers of killed or seriously injured (KSI) casualties. In 2013, they comprised around 30% of male cyclists but account for only 25% of the miles cycled. In comparison, cyclists in their 30's and 40'scycle the most, accounting for 50% of miles cycled, but formed only 40% of male KSI in 2013.

The pattern for females is very different. The most over represented age group of females are aged between 50 and 59 years. This age group accounts for around 8% of miles cycled by females, but 16% of casualties.

In collisions involving a bicycle and another vehicle, the most common key contributory factor recorded by the police is "failed to look properly" by either the driver or rider, especially at junctions. "Failed to look properly" was attributed to the car driver in 50% of collisions and to the cyclist in 42% of collisions. The second most common contributory factor assigned to both pedal cyclists and drivers was 'failed to judge other persons path or speed'.

Between 2009 and 2013, 30% of cyclists killed or seriously injured at crossroads and staggered junctions happened as a result of the pedal cyclist 'going ahead' and a motor vehicle turning right or left across their path. 20% were as a result of both the pedal cyclist and the other vehicle 'going ahead'. Away from junctions, 13% of killed or seriously injured cyclists were the result of the cyclist being overtaken by a motor vehicle.

Other common contributory factors attributed to drivers are "poor turn/manoeuvre" (in 17% of serious accidents involving a cyclist) and "careless, reckless, in a hurry (17%). Cyclists are more likely to suffer serious injuries when a driver is judged to be "impaired by alcohol", exceeding the speed limit" or "travelling too fast for the conditions".[16]

Another common contributory factor attributed to cyclists was "cyclist entering the road from the pavement" (including when a cyclist crosses the road at a pedestrian crossing), which was recorded in about 20% serious collisions (and over one third of serious collisions involving child cyclists).

The most common vehicle involved in collisions with cyclists is a car or taxi, with the rider usually being hit by the front of the vehicle. In a quarter of fatal cyclist accidents, the front of the vehicle hit the rear of the bicycle.

Road safety is connected with many other social issues. Injuries are not evenly distributed through society; the risk of being injured as a cyclist is greater for people from lower socio-economic groups, especially for child cyclists where there is a large difference in the risk of injury between the most and least affluent.

A RoSPA review[17] of the social determinants of injury found that the difference is most likely due to differences in the amount of road use by cycle, in the design of the physical environment and in the social environment. Addressing or mitigating these social determinants could help to reduce cyclist injuries. This could be done through road design, and the introduction of 20mph zones is effective at reducing inequalities, for example. Many of the approaches suggested by the Marmot Review[18] to tackle the social determinants of health may also be beneficial.

Summary of Cyclist Accidents [19]

- Around 75% of fatal or serious cyclist accidents occur in urban areas, where most cycling takes place, but about half of cyclist deaths occur on rural roads
- Most (75%) of cycling accidents happen at, or near, a road junction, with roundabouts being particularly dangerous junctions for cyclists
- The severity of injuries suffered by cyclists increases with the speed limit; riders are more likely to suffer serious or fatal injuries on higher speed roads
- Most (80%) of cycling accidents occur in daylight, but they are more likely to be fatal in the dark
- More cycle accidents occur in Spring and Summer than Autumn and Winter, but the casualty rate is higher over the Autumn and Winter
- Most (80%) of cyclist casualties are male
- Almost one quarter of the cyclists killed or injured are children
- Accidents involving child cyclists are often the result of the child playing, doing tricks, riding too fast or losing control; teenage and adult cyclists accidents are more likely to involve collisions with motor vehicles
- About 16% of fatal or serious cyclist accidents reported to the police do not involve a collision with another vehicle
- In collisions involving a bicycle and another vehicle, the most common contributory factor attributed to the driver is “failed to look properly”, especially at junctions (57% of serious collisions)
- Other common factors attributed to drivers are “poor turn/manoeuvre” (in 17% of serious accidents involving a cyclist) and “careless, reckless, in a hurry” (17%)
- Cyclists are more likely to suffer serious injuries when a driver is judged to be “impaired by alcohol, exceeding the speed limit or “travelling too fast for the conditions”
- Failed to look properly was also the most common contributory attributed to the cyclist (42% of serious collisions at junctions)
- The second most common one was “cyclist entering the road from the pavement” (about 20% of serious collisions; over one third for child cyclists)
- HGVs present a particular danger for cyclists, especially in London where around 20% of cyclist fatalities involve an HGV; they often occur when an HGV is turning left at a junction
- About one quarter of accidents resulting in serious injury to a cyclist involved an HGV, bus or coach “passing too close” to the rider
- Limb injuries are common in cyclist casualties, with over 40% suffering arm injuries and around 25% suffering leg injuries
- Approximately 40% of cyclists admitted to hospital received a head injury
- Chest and abdomen injuries occur much less frequently (5%), but are often serious.
- Head injuries, ranging from fatal skull fractures and brain damage to minor concussion and cuts, are very common injuries to cyclists. Hospital data shows that over 40% of cyclists, and 45% of child cyclists, suffer head injuries

Cyclist Casualty Rates

Assessing whether or not cycling safety is improving requires a rate-based measurement as well as measuring changes in the number of casualties. It is important to know whether any increase in cyclist casualties is due to more cycling or to cycling becoming less safe (or both). More cycling may result in more cyclist casualties, but a reduction in the casualty rate per distance travelled. This data is important to assessing the success of any approach to improve cycle safety.

Therefore, it is important to have accurate data on the amount of cycling in both urban and rural areas. Once a critical level of cycling is reached, a "safety in numbers" effect may be realised, whereby the accident rate decreases because infrastructure improvements have been made to accommodate their increased numbers, and drivers expect to see them virtually anywhere and adapt their driving accordingly.

There is debate over whether an increase in cycling reduces the risk or whether less risky environments lead to more cycling.[20]

Benefits versus Risks

For individuals who cycle rather than drive, the wider health benefits generally outweigh the injury costs. However, history has also shown that when there is more travel by bicycle, there are more cyclist fatalities, despite a lower risk per cyclist. This has resulted in a debate as to whether the benefits are sufficient to warrant the potential risks from cycling.

One study concluded that the estimated health benefits of cycling were substantially larger than the risks relative to car driving for individuals shifting their mode of transport.[21] A study conducted in Barcelona [22] concluded that public bicycle sharing initiatives have greater benefits than risks due to improved health and reduced carbon dioxide emissions.

Research[23] has also found that slightly more walking and cycling accompanied by the same decrease in car use was broadly safety neutral, but that a large shift from driving to walking or cycling could reduce accidents. Another study suggested that replacing 10% of car trips shorter than 7.5 km by bicycle would be safety neutral.[24]

It is not inevitable that more cycling will lead to more cycling accidents. Even greater overall health benefits can be achieved from cycling by preventing cyclist deaths and injuries with the right strategies, investment and measures.

Current public policy

The Governments of the United Kingdom all have similar aspirations to increase the number of people cycling, and safety of these cyclists. Key policy documents include: the DfT Cycling Delivery Plan 2014, Get Britain Cycling: All Party Commission 2013, Active Travel Bill Wales 2013 and More People Cycling More Often: The Scottish Government 2010. For example, Get Britain Cycling discusses the need to change the culture of how we use our roads so that people are no longer afraid to cycle or allow their children to do so.

The UK Governments' vision is that walking and cycling becomes the natural choice for shorter journeys - or as part of a longer journey- regardless of age, gender, fitness level or income, is the DfT Cycling Delivery Plan. Within England the Cycling Delivery Plan explains how this will be achieved. Key element includes:

- Local Authorities developing a local walking and cycling delivery plan.
- The appointment of an influential cycling and walking champion, who would be an elected member.
- The cycle proofing of new transport infrastructure.

Currently, around £5 per person is spent annually per person in England and the government's aspiration is to achieve as a minimum £10 per person by 2020-21. This said recent years have seen considerable investment in cycling across the UK. Between, 2011-15 £374 million has been allocated to support cycle schemes. The UK Government has also put much funding into the Demonstration project, the Cycling City and Towns Programme[25]

In 2013, the government announced that Manchester, Leeds, Birmingham, Newcastle, Bristol, Cambridge, Oxford and Norwich would share £77million to improve existing and fund new cycle routes. The majority of funding is channelled through Local Enterprise Partnerships (LEPs) and Local Sustainable Travel Fund (LSTF).

Fundamental to achieving this aim of increasing cycling across the UK is the need to create an infrastructure which is 'fit for purpose'. The Walking and Cycling Delivery Plan talks about "Cycle Proofing the road network to ensure that cyclists are considered at the design stage of new and improved road infrastructure. This is echoed in the Active Travel Bill Wales 2013, which places a requirement on local authorities to continuously improve facilities and routes for walkers and cyclists.

The Scottish Government has a similar vision, which is that by 2020 10% of all journeys will be by bike. The aim is to achieve these through focussed leadership, funding, infrastructure and safety.

Traditionally, cycling was seen as a highway authority responsibility; however, there is now much public health interest in cycling given its health benefits, as indicated by the Royal Society for Public Health and the Faculty of Public Health's recommendations for encouraging more cycling.[26] There is a clear role for the new public health staff and the Health and Wellbeing Boards to work closely with transport planners and road safety professionals. The number of people of all ages reported killed or seriously injured on the roads per 100000 resident populations is an indicator in the Public Health Outcomes Framework.

Cycle Safety Action Plans, such as the London Cycle Safety Action Plan[27] and the Cycling Action Plan for Scotland,[28] provide a strong framework for combining increased cycling with reduced cyclist casualties.

A SAFER CYCLING ENVIRONMENT

Generally, successful attempts to prevent injury have been based around changing the physical environment. These approaches have been called 'passive' as they do not require a large proportion of the population to change their behaviour in order to be effective.

There are two general approaches that can create a safer physical environment:

- Introducing a 'safe system' approach to road design that makes fatal injury unlikely
- Reducing motor traffic volume

The WHO safe system approach to road safety

The safe systems approach is advocated by the World Health Organisation and Vision Zero philosophy[29] and is based on the understanding that injury is caused by an exchange of energy in quantities higher than human tolerance to it. Preventing or minimising the exchange of energy therefore prevents injuries.

The safe system approach has been adopted in some countries, such as The Netherlands, Sweden, and New Zealand, and components of the approach have been adopted in the Safe streets for London Action Plan[30].

The safe system approach recognises that people make mistakes, and so roads and vehicles should be designed so that these mistakes do not frequently result in death. This places human vulnerability to injury at the centre of road design, and proposes that roads, vehicles, and traffic speeds should be modified to prevent exchanges of energy which are likely to cause fatal injuries. This approach can be applied to all types of roads and can be adopted to prevent injuries to all road users.

In general, the safe system philosophy identifies ways of separating traffic, especially vulnerable road users on high speed roads. Where this cannot be achieved, the roads are designed to reduce traffic speed.

Although there has not been an estimate of the proportion of cycling injuries that could be prevented by adopting the safe system, there have been several estimates of how many overall lives could be saved by the safe system in total.

One study[31] examined the circumstances of 215 fatal crashes, which accounted for a total of 248 fatalities, in Sweden in 2004, and estimated what circumstances would be expected in a safe system. In 63% of all the crashes in the study it was judged that the road or vehicle did not meet the safety standards that would exist if the safe system approach had been fully implemented. These fatalities could, therefore, have been prevented by the safe system, even without addressing road user behaviour.

An Australian study used a similar method, based on coroner's reports for every fatal crash in Southern Australia in 2008[32]. After some exclusions to remove intentional crashes, and crashes due to natural causes (for example, heart attack or stroke whilst driving) there were 83 crashes and 93 deaths in the sample. In this study,[33] 57% of the crashes were categorised as a failure of the safe system.

The WHO Health Economic Assessment Tool for Walking and Cycling can be used to put a financial value on the benefit from plans to increase the amount of habitual cycling. This tool can be used in transport planning and is available at: http://heatwalkingcycling.org/

Reductions in motor vehicle traffic

The level of motor vehicle traffic is an underpinning cause of injury on the roads, with greater traffic volumes leading to greater numbers of injuries. Several studies have also found that traffic volume is predictive of the number of cyclist injuries[34,35] Reducing traffic volume has the potential to improve cycle safety and road safety in general.

A study[36] on the introduction of seat belt laws in February 1983 included a measure of the number of kilometres travelled by cars in a month, and found that a 1% increase in traffic led to a 0.77% increase in cyclist casualties and a 1.12% increase in cyclist fatalities (although given the low numbers of monthly cyclist fatalities, the latter figure may be unreliable). Changes in traffic volume had a larger influence on the number of cyclist injuries than changes in cyclist volume.

A study of traffic volumes and cyclists injuries on the Island of Montreal[37] between the start of 1999 and the end of 2003, found a relationship between traffic volume and the number of all injuries and specifically that an increase of 1,000 vehicles a day was associated with a 5% increase in cyclist injuries.

Another study[38] found that while increases in walking and cycling accompanied by a corresponding decrease in car use were safety neutral or resulted in a small change in the number of accidents, larger decreases in car use should result in road safety benefits. An example of this model is presented in tables 1-3 below.

Table 1, the relative number of accidents predicted at different levels of traffic volume

Annual average daily traffic			Relative number of accidents
Motor vehicles	Pedestrians	Cyclists	
2000	200	100	1
5000	200	100	2.4
10,000	200	100	4.72
20,000	200	100	9.33
30,000	200	100	13.95

Table 2, the relative change in the number of accidents following a reduction in motor vehicles by 25% with a corresponding increase in walking/cycling

Annual average daily traffic			Relative change in the number of accidents
Motor vehicles	Pedestrians	Cyclists	
1500	530	270	0.842
3750	1030	520	0.882
7500	1860	940	0.918
15,000	3530	1770	0.957
22,500	5200	2600	0.981

Table 3, the relative change in the number of accidents following a reduction in motor vehicles by 50% with a corresponding increase in walking/cycling

Annual average daily traffic			Relative change in the number of accidents
Motor vehicles	Pedestrians	Cyclists	
1000	870	430	0.621
2500	1870	930	0.662
5000	3530	1770	0.697
10,000	6870	3430	0.734
15,000	10200	5100	0.757

Reducing cyclist injuries through safer road infrastructure

The safe system model includes many measures to prevent fatal collisions from occurring. The two main approaches are:

- Separating different road user by physical infrastructure
- Where separation cannot be achieved then vehicle speeds can be reduced so that if a collision occurs that it would do so at a speed unlikely to cause fatal injury

BS ISO 39001, "Road Traffic Safety Management Systems" advocates the adoption of a Safe System approach. It states that high levels of safety can be attained by achieving a good match between the function of the road, safe speed limits and their compliance and design and layout. Typical issues include separating on-coming traffic on high volume, high-speed roads to prevent head-on collisions and providing crash protective roadsides to address run-off road collisions. Adopting safe systems will equally be beneficial in protecting vulnerable road users.

20mph limits

There has been an expansion of 20mph limits in the UK recently. The reasons for this rapid expansion are not solely for road safety; many are being introduced to contribute towards healthier environments, for example, by encouraging more active travel and social connectivity. They are an example of where there is a good synergy between road safety and other public health outcomes.

The risk of a pedestrian or cyclist sustaining an injury at different speeds decreases significantly between 30mph and 20mph. Several studies have estimated this decrease in injury risk, predominantly by looking at pedestrian injuries, and are shown in table 4 below.

Country and years of data analysed	Most likely estimated risk of death at 20mph	Most likely estimated risk of death at 30mph
1. GB 1985–1979[39]	2. 5%	3. 45%
4. Germany 1991–2003[40]	5. 4%	6. 14%
7. GB 2000–2007[41]	8. ~2%	9. ~12%
10. South Korea 2003–2005[42]	11. 7%	12. 37%
13. Germany 2003–2007[43]	14. ~1%	15. ~8%

In Portsmouth, a 20mph limit was introduced on around 94% of roads that previously had a 30mph limit[44]. Traffic speed was monitored before and after the introduction on 223 sites to establish effectiveness. There was an overall average speed reduction of 1.3mph following the introduction of the limits, as the average speed dropped from 19.8mph to 18.5mph. The change in speeds varied from a reduction of 0.6mph to 1.7mph, and across the city this was a statistically significant reduction.

Bristol has also piloted 20mph limits in two areas.[45] Two years after the introduction of the lower limits, speed surveys on 10% of the roads covered by the scheme found a reduction in mean daytime speeds on 65% of the roads. On residential roads, there was on average a 0.4mph reduction in traffic speeds. There was a greater reduction on main roads, as 1.7mph was the average reduction in the Inner East area and 1.3mph in the Inner South area.

Cycling infrastructure

To date, there has been one systematic review examining the impact that cyclist infrastructure has on the safety of cyclists.[46] A Cochrane review of the same issue is being conducted.[47] Fifteen hundred cycling trips were recorded in America;[48] for these trips the two most important factors influencing cyclists' road choice were avoiding streets with lots of vehicle traffic and minimising total distance. Riding in a cycle lane was ranked third.

Cycle tracks and lanes

The systematic review identified fifteen evaluations of cyclist infrastructure such as lanes, paths and tracks. Predominantly the studies were from the US. There were large differences between the study methods, and they used different measures of injury (such as police reported collisions, hospital admissions or self-reported collisions). Some studies included falls from the bike in the total number of injuries. There were different definitions of cyclist infrastructure between the studies, and some studies grouped together different types of cyclist infrastructure so that facilities that may have greatly different risks were grouped together under the same category.

The reviewers concluded that on-road marked bike lanes consistently reduced injuries compared to unmodified roads.

The evidence around off-road riding was less consistent, due to the varied nature of the infrastructure – such as the surfaces – and the inclusion of falls in some studies. Two studies of off-road bike paths found reductions in risks, and studies looked at un-paved off-road trails found higher risks of injuries.

An evaluation[49] of six physically separated bicycle tracks in Montreal found that the risk of collision per mile decreased by 28% compared with streets without tracks. This study used automated bicycle counts to calculate the distance travelled on different types of road, and both medical response and police data on injuries.

A study[50] comparing the sites of cycle crashes in Iowa between 2007 and 2010 with control sites matched by census data and type of road estimated that on-road cycle facilities reduced the risk of injury, however, despite the large estimated reduction, none of the estimates were statistically significant. Studies[51] have also highlighted design measures that can prevent cycle injuries from falls or single vehicle collisions, for example, through edge markings and improving the conspicuity of bollards.

Shared routes
Shared use routes are set away from the road and are designed for use by both cyclists and pedestrians. They can have a white line segregating cyclists and pedestrians or they may be left open for the two to mix. Cyclists in one study[52] were willing to travel longer distances to make use of a shared route rather than be on the road. These routes were used as a way of avoiding streets with high levels of traffic.

Whilst shared routes can reduce conflict between motor vehicles and cyclists they increase the number of interactions between pedestrians and cyclists, which sometimes (but not always) can cause problems. When a canal side towpath was opened up to cyclists, no change in attitudes was seen in walkers or anglers at the site, even with an increase in cyclist use.[53] Alternatively, on another shared route, concern was expressed by some users about cyclists who were behaving inconsiderately.[54]

Shared space
Shared spaces are where the distinction between the space allocated to motor vehicles and the space allocated to pedestrians is removed, so that motor vehicles become less dominant.[55] In a shared space, cyclists do not experience the same restrictions as in other pedestrian areas.

Research[56] commissioned by the DfT to inform their guidance on shared spaces, concluded that:

- Drivers travelled at lower speeds and were more likely to give way to pedestrians
- The full benefits of a shared space were more likely to be seen if multiple characteristics of a shared space were put in place
- That shared space design needs to be inclusive and understood by all. This includes making provision for vulnerable users of the space[57].

Junctions and intersections
The systematic review[58] also included eight studies of the risk of injury at intersections. These were mainly conducted in European countries, although there was variation in study design and data sources.

Introducing roundabouts with multiple lanes appeared to increase the risk of cyclist injuries at roundabouts. Separated cycle lanes were found to decrease injury risks to vulnerable road users in two studies, although neither looked at the injury risk to cyclists separately.

A study on coloured (blue) crossings came to uncertain conclusions, as it found that one blue crossing decreased the risk of injury but others increased the risk. They hypothesised that a larger number of blue crossings created a complex environment and confusion for road users.

A second study of the effects of providing a cycle lane that was raised above the road level by 4-12 cm found an 8% increase in police and hospital reported crashes, but also a 50% increase in cycle volume compared to sections that had remained unchanged.

Other papers since the review have examined the effectiveness of raised intersections. A study of 540 intersections at unsignalled junctions in the Netherlands between 2005 and 2008[59] found that, for crashes that occurred where cyclists had the right of way, raised bicycle crossings (and other speed reducing measures for vehicles entering or leaving the side road) halved the number of crashes and almost halved them if there was a 2m to 5m distance between the cycle track and junction. The number of crashes increased when bicycle crossings were marked in red.

Street lighting

The systematic review[60] identified one paper about the effects of street lighting on cyclist injuries in rural areas. It used police records from 125,000 crashes in the Netherlands between 1987 and 2006, and found that lighting on rural roads reduced the number of cyclist injuries by around 60%. This finding is consistent with other evidence from systematic reviews that street lights are effective at preventing traffic injury.[60]

Reducing cyclist injuries through spatial planning

Land use determines traffic patterns. Over the last 60 years many new developments, such as out of town shopping centres, retail parks and business parks, have decentralised functions away from better connected city centres. Car ownership has become more necessary to access a range of these services. This increase in car ownership has been accompanied by decreases in the number of trips made by bicycle, which fell significantly during the 1950s.[61] The creation of new roads to accommodate this growth in motor vehicle traffic frequently created new traffic, resulting in more traffic than anticipated and further congestion.[62]

Land use is, therefore, one of the wider causes of traffic injuries. Given the relationship between motor vehicle traffic and cyclist injuries as discussed, addressing the factors that encourage car dependence and discourage people to choose to travel by cycle can help to prevent injuries.

The main aspects of land use that influence road safety[63] are:

- the spatial distribution of origins and destinations of road journey;
- urban population density and patterns of urban growth;
- the configuration of the road network;
- the size of residential areas;
- alternatives to private motorised transport

The National Planning Policy Framework supports these objectives, and one of the 12 core planning principles is to promote mixed use developments. Many specific paragraphs also support approaches to planning that make cycling and walking a feasible choice and reduce car dependence for many journeys, and therefore traffic volume:

The transport system needs to be balanced in favour of sustainable transport modes, giving people a real choice about how they travel [paragraph 29]

Plans and decisions should ensure developments that generate significant movement are located where the need to travel will be minimised and the use of sustainable transport modes can be maximised. [paragraph 34]

The planning system can play an important role in facilitating social interaction and creating healthy, inclusive communities. Local planning authorities should create a shared vision with communities of the residential environment and facilities they wish to see. To support this, local planning authorities should aim to involve all sections of the community in the development of Local Plans and in planning decisions, and should facilitate neighbourhood planning. Planning policies and decisions, in turn, should aim to achieve places which promote:

- *opportunities for meetings between members of the community who might not otherwise come into contact with each other, including through mixed-use*

developments, strong neighbourhood centres and active street frontages which bring together those who work, live and play in the vicinity;

- *safe and accessible environments where crime and disorder, and the fear of crime, do not undermine quality of life or community cohesion; and*
- *safe and accessible developments, containing clear and legible pedestrian routes, and high quality public space, which encourage the active and continual use of public areas.* [paragraph 69]

Cyclists and Pedestrians

It is important that designing for cycling is not done in isolation, without a full understanding of the street or context in which it is located. This is more likely to happen when practitioners are tasked with designing for one mode of travel in isolation. Investing in cycling facilities without the adequate consideration of people on foot is counter-productive to creating safer, more liveable and healthier places.

Living Streets recommend the following overarching principles and design principles:

1. Residents of a town or city should be invited to walk and bike as much as possible in connection with their daily activities.

2. Cycling and walking are entirely legitimate, desirable, everyday, 'grown up' modes of transport, worthy of investment.

3. Both pedestrians and cyclists are highly vulnerable to, and restricted by, motor traffic. Increasing cycle and walking mode share should be part of an integrated approach to decreasing car mode share.

4. Walking and cycling are two very different modes: mixing them together inappropriately can cause fear, anxiety, insecurity and even serious injury.

5. Improving cycle safety and convenience should not diminish pedestrian safety and convenience.

6. Any change to the street environment must take into account the accessibility needs of all kinds of users.

7. Where a satisfactory balance between road users cannot be achieved, a framework for identifying priority between them must apply. 'Capacity to cause' harm (health, climate change, noise, danger to others and air pollution) should underpin this decision-making.

8. Context is key – standard design solutions must not be 'dropped in' without a full appreciation of the street's own unique context and many different functions. Local people must be consulted and existing use measured (for example, pedestrian flows, and desire lines).

Design principles

Safe: Recognise pedestrians and cyclists as vulnerable road users: reduce the risk of collisions, make infrastructure that both pedestrians and cyclists feel safe using, and improve driver behaviour. For example, slower speeds avoid putting cyclists and pedestrians in danger.

Comfortable: cycling facilities should not diminish the pedestrian comfort or result in anxiety. They must take into account the accessibility needs of all kinds of users.

Direct: cycling facilities should complement pedestrian facilities and avoid creating delay or diversion for those on foot.

Coherent: shared or adjacent facilities should be consistent, predictable and intuitive to use for cyclists and pedestrians so not to cause conflict between the two.

Attractiveness: improvements for cycling should contribute to more appealing, attractive and liveable places for everyone.

Adaptable: cycling facilities should be designed so that they can adapt over time if pedestrian and cyclists demand increases.

IMPROVING ROAD USER BEHAVIOUR

Most road crashes are at least partly, and sometimes mainly, due to human error, which can range from simple mistakes and misjudgements to deliberately dangerous and illegal behaviour.

Creating a safer cycling environment will help to improve the behaviour of all road users, by making it easier for them to behave responsibly and safely. Education (including training and publicity) and enforcement are also key approaches to improving road user behaviour, and to helping everyone share the road safely together. However, all road users, including cyclists and drivers, must also take responsibility for their own choices and behaviour.

Cyclists

In collisions in which cyclist behaviour was judged to have been a contributory factor, the most common reasons recorded by the police is "failed to look properly", especially at junctions, and 'failed to judge other persons path or speed'. These are also common errors by drivers.

Another common contributory factor attributed to cyclists is "cyclist entering the road from the pavement" (including when a cyclist crosses the road at a pedestrian crossing), which was recorded in about 20% serious collisions (and over one third of serious collisions involving child cyclists).

Compliance with road traffic law

Research has shown that some non-cyclist road users hold a negative stereotype of cyclists, viewing them as a group who have a tendency to break road laws.[64] The public often perceive cyclists as frequently jumping red lights and cycling on the pavement. Studies have shown that the proportion of cyclists violating red lights varies dependent on the site but can be anywhere between 3% and 36%.[65,66] It should be noted that 96% of pedestrians who were injured by a vehicle red light jumping, were hit by a motor vehicle and only 4% by a cyclist.[67]

When not identified as part of a shared route or shared space, pavement cycling is illegal. Living Streets cites how pavement cycling can be a barrier to walking and is particularly intimidating to vulnerable pedestrians.[68] When asked, many cyclists say they ride on pavements because of the danger posed by traffic on the road.[69] Some of those interviewed recognised that this is inconsiderate to pedestrians and would dismount in busy areas. Improving infrastructure and traffic speeds could encourage cyclists not to ride on pavements.

However, less is known about the number cyclists using pavements. Initial figures from Operation Safeway showed that, within the first eight weeks, the Metropolitan Police issued 14,000 fixed penalty notices, of which 1,200 were for cycling on the pavement.[70] Between 1998 and 2007 in London, 2% of pedestrian collision injuries involved a cyclist on the pavement, whereas the remaining 98% involved a motor vehicle[71].

Training

Practical cyclist training schemes to the National Standards for Cyclist Training[72] are an important way of enabling cyclists to stay safe and of encouraging more cycling. There is little, and almost no recent, research into the effectiveness of cyclist training. A review of older research studies found some evidence that practical cyclist training, especially if it is on-road, can improve children's cycling knowledge and behavior.[73]

Evidence into the impact of training on accidents and injuries is particularly sparse. One study found trained children were less likely to become a casualty[74] whereas another found no relationship between training and accidents.[75] An evaluation of practical cyclist training schemes is needed.

At the end of 2012, Birmingham City Council road safety team ran a project called "Women on Wheels", a training course targeted primarily at adult women from ethnic minorities. Level 1 or level 2 Bikability training was delivered without charge and course participants were able to borrow bicycles for the training. The evaluation showed that after the training, participants reported that they had improved their cycling skills and confidence. This is a good example of a project that was led by a road safety team and encouraged both safe and active travel.[76]

Notwithstanding the above evaluation, there is a general lack of good evaluations of road safety education, training and publicity (ETP) interventions, partly because it is much more difficult to evaluate education interventions, than engineering ones, but also due to a lack of capacity within the road safety profession. To help address this, www.roadsafetyevaluation.com, and E-valu-it, an interactive tool to help practitioners plan, conduct and publish evaluations of their road safety education interventions. This can be used to evaluate cycling safety interventions.

Cycle Helmets

RoSPA strongly recommends that cyclists wear a cycle helmet, as it reduces the risk of suffering a serious head or brain injury in an accident. Cycle helmets do not prevent crashes, nor guarantee survival, but they do provide a last line of defence for the cyclist's head.

RoSPA does not support calls for compulsory cycle helmet laws because it is not clear whether such a law would discourage some people from cycling, thereby losing the health and environmental benefits from cycling.

Research has found that cycle helmets prevent serious injury and even death.[77] However, it is also argued that helmet wearing does not mitigate certain risks. One study[78] contends that the most serious brain injuries are caused by rotation, which helmets are not specifically designed to deal with. A report by TRL,[79] however, found no evidence of increased risk of rotational injury when wearing a helmet than when not wearing one.

Education programmes are one method to promote cycle helmet use. Some programmes with children have been shown to increase helmet use as well as reduce the number of cycle related head injuries[80]. Other programmes, however, have proved ineffective[81] or not to have worked as well with different social groups, such as those on low incomes.[82]

There has also been some dispute as to whether wearing a helmet can affect the likelihood of being involved in an accident. For example, cyclists and drivers may behave in a riskier manner because of the perceived protection that a helmet provides.[83] Other researchers have argued that it is unlikely that the level of risk would be so great as to completely negate the effects of wearing a helmet.[84]

Lights and high visibility clothing

Around 80% of cycling accidents occur in daylight - which is when most cycling takes place. For child cyclists, 90% of their accidents occur during the day. Research into the effectiveness of cyclists using lights during daylight should be considered as an additional safety feature as is the case with motorcycles.

However, cycling accidents in the dark are more likely to be fatal.[85] In 2013, "Not displaying lights at night or in poor visibility" was recorded as a contributory factor in 309 pedal cyclist accidents and "Rider wearing dark clothing" in 489 reported pedal cyclist accidents[14]

The law about the use of lights and reflectors is very clear; Highway Code (rule 60) says:

'At night your cycle must have white front and red rear lights lit. It must also be fitted with a red rear reflector (and amber pedal reflectors, if manufactured after 1/10/85). White front reflectors and spoke reflectors also help cyclists to be seen. Flashing lights are permitted, but it is recommended that cyclists who are riding in areas without street lighting use a steady front lamp.

There is no legal requirement for pedal cyclists (or any other road user) to wear high visibility garments.

There is very little research to show the effectiveness of cycle lighting and high visibility clothing.

One study [86] conducted at Bath and Brunel universities involved 269 participants riding bikes with ultrasonic devises fitted to measure the distance motorists overtook them while they wore a variety of cycling kit. This included typical sporting rider's lycra, casual clothing and hi-visibility vests. The research found that the only clothing which made a difference to the average passing distance was a high visibility vest with the words police and a notice advising drivers that the rider was videoing their ride. This increased the average passing distance from 117cm to 122cm. This report did not evaluate the relationship between wearing high visibility clothing and how soon a rider was seen by the driver in various lighting conditions. Further scientific investigation is required to clearly answer this question.

Despite the lack of research, RoSPA fully supports the advice in the Highway Code (rule 59) in relation to the wearing of clothing which says that a rider should wear light coloured or fluorescent clothing in daylight and poor light and reflective clothing in the dark.

Riders should be encouraged to make themselves as visible as possible; however, drivers equally have a responsibility to 'look out for cyclists' irrespective of the clothing which is worn as 'failed to look properly' is a major crash factor.

Regulations and standards that govern cycle lighting are out of date, and need to be updated. They have not kept pace with innovations and improvements in cycle lights.

Drivers
In collisions involving a bicycle, the most common key contributory factor attributed to drivers is "failed to look properly", especially at junctions. Other common contributory factors attributed to drivers are "poor turn/manoeuvre" (in 17% of serious accidents involving a cyclist) and "careless, reckless, in a hurry (17%). Cyclists are more likely to suffer serious injuries when a driver is judged to be "impaired by alcohol", exceeding the speed limit" or "travelling too fast for the conditions".[7]

Awareness of cyclists
Drivers can have negative perceptions of cyclists. Some drivers have described how they feel cyclists break the rules of road and can be irritated when cyclists affect their own convenience whilst driving.[87] Drivers feel they should give consideration to cyclists but this can conflict with a feeling of pressure from other drivers. For example, when roads are narrow drivers may feel pressurised to overtake cyclists without giving them sufficient space. Drivers have commented that they feel more confident when there is infrastructure to define the road space[88].

Little research exists to show that cyclists, who are also drivers, are more aware of cyclists needs and modify their driving accordingly when near to and passing cyclists, however, this is a reasonable assumption to make.

Training
Once they have gained their full driving licence, few drivers choose to take any form of further driver training, even though there are many options available, ranging from quick and easy training that focuses on specific issues or skills to longer courses leading to full advanced driving tests.

However, one of the most difficult challenges is to raise awareness of the existence and benefits of refresher training. Most drivers do not feel they need refresher training, never think about it, or are not aware of its benefits.

In addition to normal driver development training, specific cycle awareness training for drivers are also available, although they have largely concentrated on professional large vehicle drivers. A number of councils in London, for example, have committed to providing cycle awareness training for their lorry drivers.[89] Training schemes can include drivers and cyclists trading places, with drivers receiving cycle training and cyclists getting into the HGV cab, to help both parties understand the road from the others perspective[68]. No formal evaluations have been conducted on these particular schemes to determine their effectiveness, but studies have shown that advanced driver training can improve situational awareness more generally.[90]

Space
Drivers should give cyclists as much space as they would a car when overtaking.[91]

Pedal cyclists are also easily affected by side winds when being overtaken and in the last five years, 13% of cyclist deaths and serious injuries in crashes away from junctions were a result of the cyclist being overtaken by a motor vehicle.

Sometimes drivers may find it difficult to give cyclist sufficient space when roads are narrow, as they can feel pressurised by other drivers to overtake a slow moving road user[80]. One study[92] concluded that drivers tend to slow down more when overtaking cyclists where there are narrower lanes, lower speed limits and the absence of centre line markings.

There is evidence to suggest that drivers modify the amount of space they give a cyclist based on their appearance.[93] Drivers in one study gave less space when overtaking if the cyclist wa: further away from the edge of the road, wearing a helmet or was male. The author argued that drivers gave less room because they judged these cyclists as more predictable riders[86]. However, in another study[94] the way cyclists dressed did little to improve their safety when it comes to being overtaken by cars.

Cyclists and Lorries

Lorries present a particular danger to cyclists when the two are involved in a collision. Cyclists are less likely to be involved in a collision with a HGV than a car but when they are, they are more likely to be killed or seriously injured. Between 2009 and 2013 they were involved in 23% of deaths despite comprising only 5% of the traffic. Cars, in comparison, account for 78% of traffic, but only account for 58% of cyclist fatalities.

Reported Road Casualties Great Britain:2013 Annual Report: Proportion of traffic in GB road user type and proportion of pedal cycle casualties 2009-13.

	HGV	LGV	Bus or Coach	Cars	Motorcycles
% of GB traffic	5	13	1	78	1
% of cycle deaths	23	8	5	58	2
% of serious cycle injuries	3	7	2	84	2
% of cycle slight injuries	2	6	2	88	1
% of cycle casualties	2	7	2	87	1

A disproportionate number of female cyclists are involved in collisions with HGVs. One study found that female cyclists accounted for double the amount of HGV collision fatalities than men, despite the women in the study only accounting for 30% of total cycle time. In addition when collisions did not involve a HGV, the fatality rate in male cyclists was double that of females.[95] A key contributor could be that females are less likely to differentiate between the risks posed by nearside or offside overtaking.[96] Overtaking on the left has an increased level of risk, especially so when next to a HGV.

The left turn issue

HGVs can present a particular danger to cyclists when turning left – 55% of cyclists who were seriously injured by HGVs greater than 7.5 tonnes in London, occurred when the driver turned left across the path of the cyclist[88]. When a cyclist is on the left of a HGV, the driver may not be aware of their presence, due to them sitting in a blind spot.

In the EU, 22% of cyclist fatalities are a result of being in collision with a goods vehicle, which is greater than this mode of transport. In Belgium this figure is 43% higher than the number of deaths following collisions with cars. The same is true for the Netherlands which is 38% and 31% in Denmark.[97]

A number of infrastructure designs used in other countries could be tested in the UK, including cycle bypass lanes at junctions, specific traffic lights for cyclists where they are allowed to enter a junction first or are stopped from entering when left turning motorists are instructed to enter or allowing cyclists to turn left when there is a red light for motorists.[98] Designs, however, would need to consider the local conditions at each junction. For example, a cycle bypass may not be practical where it would impact on a limited amount of pedestrian space.

Lorry design and technological aids

One of the key approaches is to improve lorry design and HGV technology. Some changes have already been made; for example, legislation requires most HGVs to be fitted with side guards so cyclists do not get dragged under the wheels, although there are exceptions. In addition, HGVs currently sold in the EU need to adhere to the rules on mirrors (2003/97/EC) which are aimed at reducing blind spots. These rules now also apply to the retro fitting of mirrors on HGVs sold before 2007, although again some are exempt (2007/38/EC).

Suggestions which go further than the current regulations have also been made.[99] A four week trail where HGVs used mainly camera and sensor equipment showed encouraging results.[100]

	Advantages	**Disadvantages**
More mirrors than currently required	• Reduce blind spots further	• Driver needs to be looking in the right place at the right time • Hazards difficult to identify in distorted images (e.g. convex mirrors) • Increased driver workload
Cameras	• Can have greater field of view than a mirror • Images not distorted as might be with mirrors	• Increased driver workload
Windows in doors or increase the amount able to see out of windscreen	• Actual view so not distorted • Intuitive as looking where the cyclist would actually be	• Increased driver workload • Changing design of cab could impact on other regulatory requirements

Roadside mirrors e.g. at junctions	• Evidence from Germany suggested a reduction in HGV turning collisions	• Left turn collisions can be regional, cost may outweigh the benefit in areas where they are not as common
Improve side guards	• Lower ground clearance could help with left turn collisions rather than just overtaking manoeuvres	• Little evidence to suggest whether this would work in practice
Sensors and warnings	• Sensors look in the right places at right time rather than relying on the driver to	• Doesn't identify *what* is in range. If the sensor alerts too often then the driver could become less responsive to it
Introduction of rear steering control	• When turning it would allow the driver control of the rear end so the vehicle doesn't cut in as much • If cyclist is knocked over by front end could be less likely to get run over by back wheels	• Reducing cut in would increase the swing out, increasing the risk to those overtaking on the outside. Although some systems have potential to reduce cut in without swing out. • EU regulations could be a barrier – needs to be at least as safe as without the new steering and regulations might need to be amended

Management of HGV

There has also been a call for HGVs to be banned from the capital at rush hour times after a number of cycling deaths at the end of 2013. Of the 14 cyclists who died in 2013, however, only two of the deaths involved HGVs at rush hour. There are also other factors to consider if the scheme were to be implemented. For example, it could lead to an increased cost of moving goods and so an increase in prices for consumers, there could be a sudden influx in lorries just after the ban time lifts and might even lead to changes in night time driving restrictions for lorries due to increased demand.

Some have even gone so far as to say that large freight vehicles (over 3.5 tonnes) should be removed from the roads all together.[101] These researchers suggested replacing large vehicles with river and rail transport and using light goods vehicles to distribute locally. It is unclear, however, whether this would be feasible in practice.

Companies using large vehicles could also be encouraged to meet certain optional standards to improve the safety of their drivers and reduce the risk posed to vulnerable road users. Examples of these schemes in London are the Standard for Construction Logistics[102] and the Fleet Operator Recognition Scheme.[103] Motivation for companies to be involved include it being a requirement of, or an aid to, win contracts, the company wanting to improve their safety record or wanting to reduce costs such as fines and charges.

Infrastructure could also help manage the risk of HGVs to cyclists. This can encompass broad road safety measures such as implementing lower speeds but also measures which are designed to help cyclists navigate high risk parts of their journeys such as junctions.

Road Justice System

The National Cycling Charity CTC has set up the Road Justice campaign, an online tool where vulnerable road users can report dangerous driving. Their Road Justice campaign[104] describes how, in some instances, police investigations of road collisions do not always lead to justice for the victim. The report offers the following areas of recommendation to improve how the police deal with road crime:

- Thorough investigation of all road traffic collisions, including collecting information on near misses and reports of seriously bad or aggressive driving.
- Ensuring that there is sufficient resourcing and training for police to respond appropriately to road crime.
- That the support offered to victims of road crime should be similar to that of other crime and that the victim should not be blamed automatically.

MORE CYCLING WITHOUT MORE CYCLING CASUALTIES?

Safety in Numbers

Once a critical level of cycling is reached, a "safety in numbers" effect may be achieved, whereby the accident rate decreases because infrastructure improvements have been made to accommodate their increased numbers, and drivers expect to see them virtually anywhere and adapt their driving accordingly.

Another explanation for "safety in numbers" is an accompanying change in the volume of travel by car. The amount of car traffic explains the total incidence of traffic injury[11] and several studies have also found that traffic volume is predictive of the number of cyclist injuries.[105][106]Reducing traffic volume has the potential to improve cycle safety and road safety in general.

It is not inevitable that more cycling will lead to more cycling accidents. One study[107] found that slightly more walking and cycling accompanied by the same decrease in car use was broadly safety neutral, but that a large shift from driving to walking or cycling could reduce accidents. Another suggested that replacing 10% of car trips shorter than 7.5 km by bicycle would be safety neutral.[108]

Cycle Safety Action Plans, such as the London Cycle Safety Action Plan[109] and the Cycling Action Plan for Scotland[110] provide a strong framework for combining increased cycling with reduced cyclist casualties.

CONCLUSIONS

RoSPA recognises that cycling has positive and tangible health and societal benefits.

This policy paper identifies the fact that the health benefits of cycling outweigh the risks it involves, and that there are very strong reasons for enabling more people to cycle more often and more safely.

However, safe systems are required which allow motorists and vulnerable road users to interact and share the highway in a safe and responsible manner. Cycle safety measures should be put in place to include: engineering, training, education and enforcement programmes that work together to provide an environment which maximises the protection of all vulnerable road users.

RECOMMENDATIONS

Cycling should be promoted

Government, Local Authority and other cycling strategies and action plans should be supported.

The health benefits of cycling should be considered alongside the risks involved.

To facilitate the growth in cycling, while minimising the risk that this will result in increased cyclist casualties, a comprehensive range of measures should be introduced, including:

Engineering

- New cycle infrastructure to be designed in accordance with the principles of the 'SAFE STSTEM approach.
- Reduced speed limits should be considered where there is substantial cycling and pedestrian activity, or the potential for such activity. This includes the majority of built-up streets. On roads with higher speed limts, or higher traffic volumes, protected cycling facilities should be provided.
- The design and construction of cycle facilities should follow best practice from home and abroad as fully as possible.
- Wherever practical, new cycle lanes should be planned to be continuous and to give priority to cyclists at junctions. They should be of sufficient length to provide meaningful separation from traffic.
- Further research should be conducted to identify how best to provide for cyclists at junctions.
- The transport system must be balanced in favour of sustainable transport modes.
- The provision of cycling policies and facilities should complement those for pedestrians.
- Highway Authorities should consider the safety of, and improved provision for, cyclists as an integral part of their cyclical maintenance programmes (winter maintenance, vegetation cutting, surfacing, etc)
- Highway authorities should consider the safety implications, especially for cyclists and pedestrians, as well as the environmental and financial benefits when considering whether or not to switch off or reduce the level of street lighting.

Education and Training

- Practical theory and on road training for both drivers and cyclists must highlight the danger of:
    - Large vehicle collisions, especially resulting from left turn manoeuvres
    - The importance of looking out for cyclists at junctions
    - Collisions resulting from failure to look properly, frontal collision crashes, and failure to judge other persons path or speed
    - Cyclist entering the road from the pavement, including when a cyclist crosses the road at a pedestrian crossing
    - The importance of safe overtaking
- How to interact and share space with cyclists safely should be actively included in learner driver training, refresher professional driver training and driver diversionary training courses. Drivers should understand cyclist road positioning, and the reasons for it, as taught in the cyclist training.
- The use of cycle helmets, lights, reflectors and high visibility garment should be encouraged as a secondary safety feature but should not be compulsory (other than the mandatory use of cycle lights and reflectors as currently required by law).

- Research into the effectiveness of cycle lights, reflectors and high-visibility garments should be conducted.
- Practical cyclist training for teenagers and adults, as well as for children,

should be provided and promoted. In particular, the marketing of teenager and adult cyclist training should emphasise the reasons for, and benefits of, taking practical cyclist training.

Enforcement

- Locally targeted traffic enforcement should be undertaken where motorists have been identified to be causing danger and intimidation to cyclists and other vulnerable road users.
- Locally targeted and proportionate traffic enforcement should be undertaken where cyclists are seen putting themselves or other road users in danger.
- The regulations and standards that govern cycle lights should be reviewed and updated where appropriate to reflect technological advancements and improvements in cycle lighting.

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