Cycle Helmets:

The impacts of compulsory cycle helmet legislation on cyclist fatalities and premature deaths in the UK

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Introduction

The popularity of the bicycle as a means of getting around has increased significantly in recent years. In 2010, 3 billion vehicle miles were undertaken by bicycle, 15% more than 2007 – though substantially lower than in 1950 (12.4 billion vehicle miles) (Keep, 2012). Cycling has increased significantly in larger towns and cities in the UK. In London, for instance, the number of daily journeys undertaken by bicycle was an estimated 490,000 trips per day in 2010, nearly double the level of 2000 (Figure 1).

Cycling has benefitted for a number of years from significant policy support. Support for cycling in national policy is contained in *Creating Growth, Cutting Carbon: Making Sustainable Transport Happen – The Local Transport White Paper*. Delivery of cycling initiatives and schemes is funded through a number of sources, the most notable being Local Transport Plan Integrated Capital Programmes, Local Implementation Plans, and the Local Sustainable Transport Fund. The bicycles role in achieving numerous policy objectives such as in healthcare, carbon reduction, air quality and improving the quality of urban spaces has seen the bicycle become a key part in generating a sense of place, even in generating economic growth.

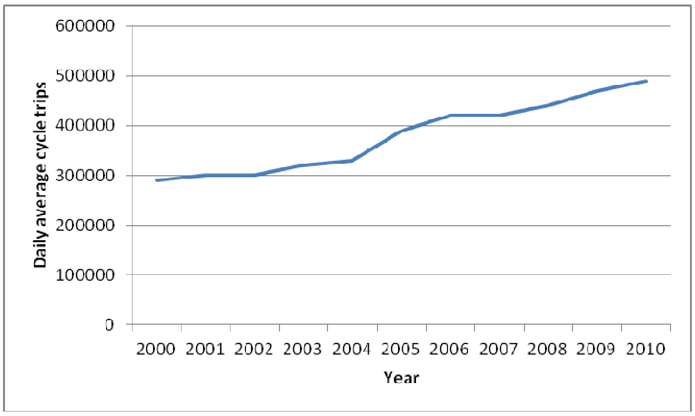

Figure 1 – Daily average number of cycle trips in London (Source: Transport for London, 2011)

The safety of cyclists is a significant transport issue. Within the last 5 years, the total number of cyclists killed in the UK has declined to 107 in 2011 (Figure 2), although provisional estimates show that this number has increased to 120 fatalities in 2012. Per mile travelled, cyclists are 34% less likely to be killed compared to 10 years ago (Figure 3), although casualty rates for cyclists killed and seriously injured have risen every year since 2008 (Figure 4). Rates of cycle crashes of all severities have decreased by 14% in 10 years (Figure 5).

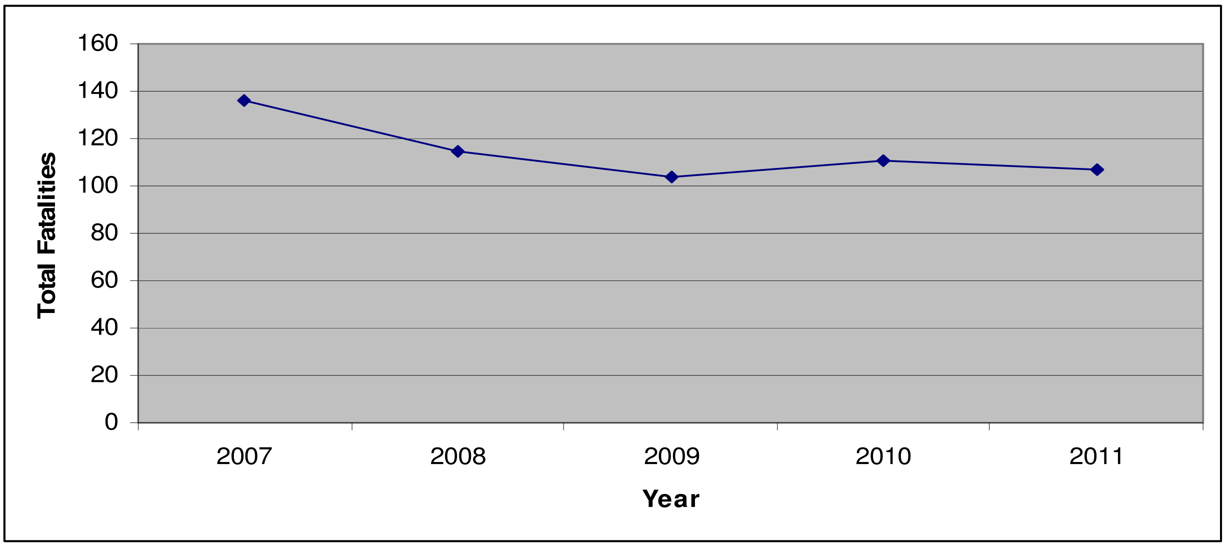

Figure 2 – Reported cyclist fatalities in Great Britain per annum (Source: Department for Transport, 2012)

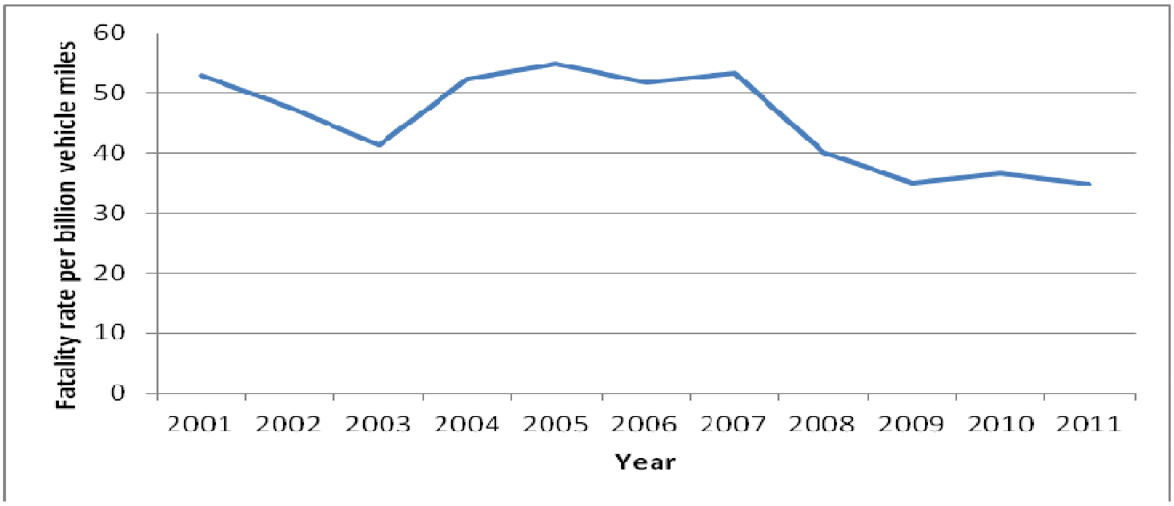

Figure 3 – Fatality rates for cyclists between 2001 and 2011 (Source: Department for Transport, 2012)

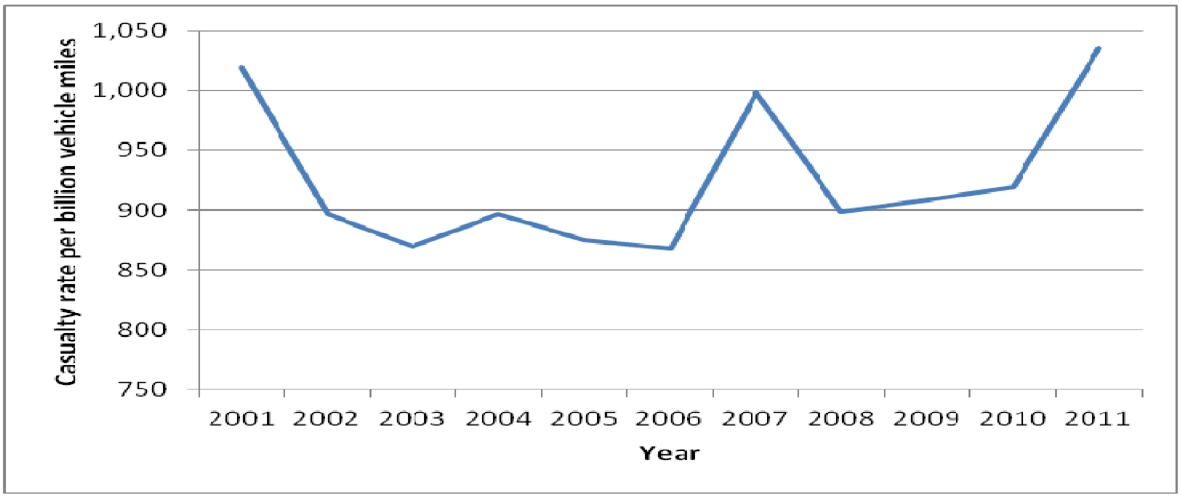

Figure 4 – Cyclist Casualty Rates (Killed and Seriously Injured) per billion vehicle kilometres between 2001 and 2011 (Source: Department for Transport, 2012)

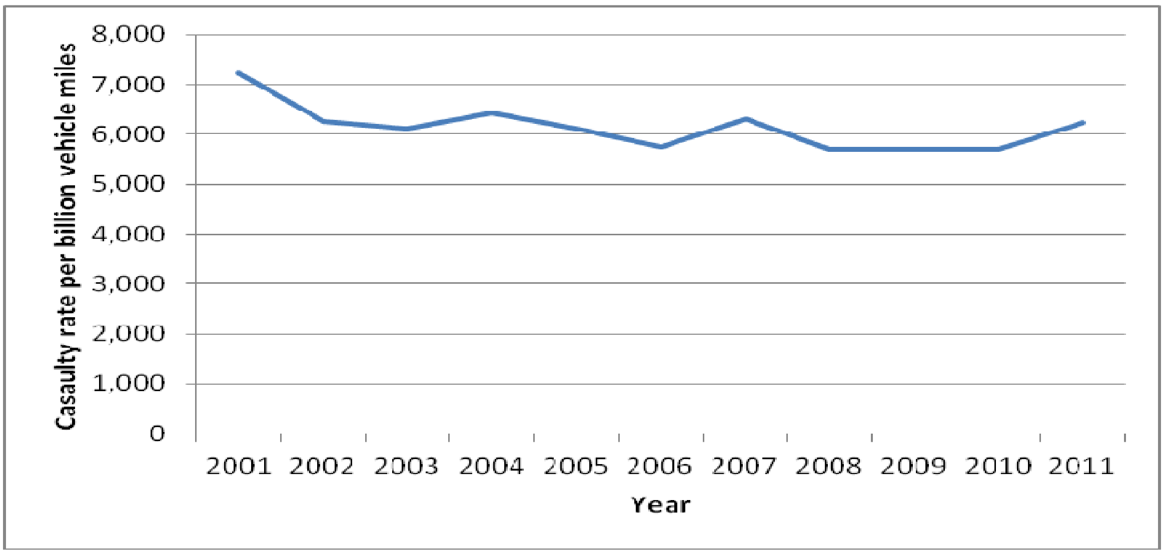

Figure 5 – Cyclist Casualty Rates (All Accident Severities) per billion vehicle kilometres between 2001 and 2011 (Source: Department for Transport, 2012)

Publicly, the cycle safety debate has been most visible through the “Cities Fit for Cycling” Campaign being led by *The Times*, which calls for ‘structural as well as geographical’ changes to cities to make them safer and more suited for cyclists (The Times, 2012). The issue of cyclist safety also featured heavily in the 2012 race for the London Mayor, with all major candidates signing the London Cycle Campaign’s *Love London, Go Dutch* commitment, with the All Party Parliamentary Group for Cycling also calling for evidence for its “Get Britain Cycling” inquiry into the barriers preventing more people from cycling in the UK.

Within the transport profession, the benefits of cycling have long been realised, and the status of cyclists as vulnerable road users has long been recognised. For those working in local authorities, this has taken on added importance given extra duties to promote public health bestowed upon highway authorities by the Health and Social Care Act 2012. It is vital that professionals are aware of and engage in all aspects of the cycle safety debate to further develop cycling.

One of the fiercest cycle safety debates concerns that of introducing laws that make it compulsory to wear cycle helmets. Currently, it is not a legal requirement for any person to wear a helmet whilst cycling in the majority of the UK (Porter, 2012), although it is recommended under Rule 59 of the Highway Code that *“you should wear…a cycle helmet which conforms to current regulations, is the correct size and securely fastened.”* It is a legal requirement for children to wear cycle helmets in Northern Ireland and Jersey, following the passing of laws in these jurisdictions. Internationally, there are over 20 countries where wearing a cycle helmet is compulsory, notably Finland (for all ages), Sweden (15 years old and under), Australia (all ages), and several US states and Canadian provinces.

The current Government position on cycle helmets is that they are a matter of exhortion rather than of compulsion (Hansard, 2012). In the UK, the percentage of cyclists wearing helmets has steadily increased on major built up roads from an estimated 16% in 1994 to an estimated 34.3% in 2008 (Sharratt *et al*, 2009). Adults are more likely to be wearing cycle helmets compared to children, with females also more likely to wear helmets than males. London cyclists also more likely to wear helmets.

Regardless, the debate still rages. Many medical practitioners, most notably the British Medical Association, argue strongly in favour of the protective effects of cycle helmets in reducing the number and severity of head injuries from cycling. Consequently, these organisations are in favour of the compulsory wearing of cycle helmets. This position is strongly opposed by cycling advocates, stating that the health benefits of cycling far outweigh both the risks of cycling and the health benefits of any cycle helmet law.

Objectives

Understanding the cycle helmet debate is essential for practitioners who wish to understand whether a compulsory cycle helmet wearing law should be promoted by policy makers, and the consequences of compulsion on promoting cycling as a healthy and low carbon means of getting around. It is also essential that, in line with new health duties placed upon transport authorities, practitioners understand the implications of making wearing cycle helmets compulsory.

This paper will first critically review the evidence informing the current debate about making wearing cycle helmets compulsory. From the evidence presented, this paper will then indicate the health impacts of a helmet law to determine whether such a law would be of net health benefit in terms of fatalities.

The Cycle Helmet Debate

The nature of the cycle helmet debate centres around 3 cores areas:

1. The assistance that cycle helmets provide in the event of a crash and the ability to reduce serious cycle fatalities and serious injuries when they occur;
2. The health benefits of cycling and the impact of compulsory helmet laws on cycling levels;
3. Whether cycle helmets affect the likelihood of an accident.

1. The assistance that cycle helmets provide in the event of a crash

In a crash, cycle helmets are designed to reduce head injury by absorbing the energy of a head impact and distributing the load across the helmet area. This is intended to reduce the risk of scalp lacerations, cranium fracture, and severe brain injury (Hynd *et al*, 2009). Around a third of serious injuries in crashess are some form of head injury (SWOV, 2012), with 39.8% of reported cycle crashes in the UK involving some sort of head or facial injury (Hynd *et al*, 2009).

Since the late 1990s, all cycle helmets sold in the UK are required to meet minimum standards as set out in EN 1078:1997 (Helmets for Older Children and Adults) or EN 1080:1997 (Helmets for Younger Children). There has been significant debate on the effectiveness of the standards applied to cycle helmet design. Hewson (2005) states there is little data on the kinetic interactions in cycle crashes, and Carpenter & Ataie (2012) question whether the testing mechanism for the standards reflects real-world collisions. A number of other contributors also highlight other factors that impact on the efficacy of cycle helmets in a collision, notably whether a helmet fits and is the correct size. This is a complex and technical debate, with merits in arguments from both sides. But for the purposes of this paper we are interested in whether cycle helmets in the round are likely to reduce fatalities from crashes.

A number of studies have been undertaken over many years to investigate how cycle helmets impact upon premature deaths, primarily from reducing the severity of head injuries sustained in crashes. Table 1 summarises some of the main studies undertaken. What is notable from the reviewed studies is the shown impact of compulsory cycle helmet laws on reduction in head injuries amongst children. This is partly as a result of the laws studies, all of which compel children to wear cycle helmets. Another factor is that because children are smaller than adults, their heads have to fall less far in the majority of crashes involving a head impact. Consequently, the vertical impact velocity of child accidents is lower. Children are also more likely to be involved in single vehicle accidents (RoSPA, 2012), i.e. fall off their bicycle. As such accidents are more likely to result in head injuries (SWOV, 2012), the impact of helmet legislation on children is likely to be greater than such a law on adults.

From the studies reviewed, of particular interest is the investigation undertaken by Hynd *et al* (2009) due to its application to the UK. By applying a bio-mechanical assessment of in-depth UK crash data, notably Police Fatal Accident Files and Hospital Episode Statistics (HES), an assessment was undertaken on the potential for cycle helmets to reduce cyclist fatalities from head injuries. This estimates a potential benefit of cycle helmet wearing of reducing cycling fatalities of between 10% and 16%.

Table 1 – Summary of research on the effects of compulsory cycle helmet laws on cyclist injuries and fatalities

Study Area	Study Method	Results	Source
UK	Use of a biomechanical assessment of in-depth UK accident data to estimate the potential of helmets to prevent cycling fatalities.	Estimate of a potential 10-16% reduction in total cycle fatalities.	Hynd *et al* (2009)
Victoria, Australia	Analysis of 4 years of collision data both pre and post compulsory helmet law being introduced	Hospital admissions with head injuries amongst cyclists reduced by 40%	Carr *et al* (1995)
Various	Meta-analysis of studies focussing on the impacts of cycle helmet use on head injuries. As this was a meta-analysis, results were not presented in defined metric, e.g. total fatalities.	Wearing a cycle helmet reduces the risk of head injury by up to 88%, and risk of facial injury by 65%	Thompson *et al* (2001)
Ontario, Canada	Controlled before and after study of legislation requiring mandatory bicycle helmets for children aged under 18 years. Intervention group: children aged between 1 and 15 years old. Control group: Older adolescents and persons aged 16 years and older. Measured in rates of mortality (per 100000 person-years).	Mortality rates decreased by 52% in the children aged between 1 and 15 years old, though cause of deaths undetermined.	Wesson *et al* (2008)
New Zealand	General population observations with specific analysis for different age groups (5-12 years, 13-18 years and 19+ years). For each of the 3 groups, helmet wearing rates compared with head injuries sustained. Measured in terms of cyclist admissions to hospitals.	Estimated that law had averted a total of 139 head injuries over 3 years (19% reduction).	Scuffham *et al* (2000)
Canada	Controlled before and after study on legislation requiring mandatory bicycle helmets for cyclists of various ages. Intervention group: Children in four provinces who had introduced cycle helmet laws (Ontario, New Brunswick, Nova Scotia, British Columbia).	45% reduction in total head injuries in the intervention provinces. 27% reduction in total head injuries in the control provinces.	Macpherson *et al* (2002)
Various	Meta-analysis of studies in a variety of countries to review the effectiveness of cycle helmets in preventing injuries. As this was a meta-analysis, results were not presented in defined metric, e.g. total fatalities.	42% reduction in the risk of head injury 53% reduction in the risk of brain injury 17% reduction in the risk of facial injury 32% increase in the risk of neck injury	SWOV (2011)

This research has been subject to much debate and discussion. In particular the report is criticised for estimating that 50% of head injuries would be prevented by a cycle helmet in the event of a single-vehicle crash, and 10%-30% in the event of an crash with a vehicle, estimates that BHRF (2012) states is without basis, and based upon the inherent assumption that helmets behave as designed in the event of an crash. Hynd *et al* (2009) accept that the results are an assessment of potential and should not be quoted as statistical fact, and that this area requires further research.

The criticisms of Hynd *et al* (2009) highlights much wider criticisms of study methods employed to investigate the impacts of compulsory helmet laws on head injuries and fatalities, ranging from reviews of police crash records to hospital admissions records. No method is without its issues, the most common of which is underreporting of actual crashes (particularly those involving minor injuries) and hospital admissions records are also influenced by changes in treatment procedures (Robinson, 2006).

Regardless of many such issues, the evidence indicates that for cyclists involved in a cycle crash with a head impact, those not wearing helmets have a greater risk of sustaining a serious or fatal head injury than a cyclist wearing a helmet. This risk is qualified on a number of factors, notably the kinetic forces involved in individual collisions, cycle helmet design standards and fitting by the cyclist.

2. The health benefits of cycling and the impact of compulsory helmet laws on cycling levels

The health benefits of maintaining an active lifestyle have long been established. It is a major component of weight control, and key to maintaining the function of muscles, bones, joints, and the cardiovascular system. People who are physically active reduce their risk of premature death and of developing a number of major diseases, notably coronary heart disease, stroke, type 2 diabetes, osteoporosis, dementia and cancer (Figure 6). Physical activity also releases endorphins, creating a sense of mental well being and tackling depression (Johan de Hartog *et al*, 2010).

In the UK, sedentary lifestyles are a national health issue. The proportion of persons who are overweight or obese has increased significantly whilst trips per head per year by active modes has decreased (Table 2). Less than a third of men and a quarter of women achieve 30 minutes of physical activity 5 times of week (House of Commons Health Committee, 2004). Increasing daily physical activity is seen as a national priority.

Physical inactivity is a significant social and economic cost to the UK. The estimated total cost of physical inactivity to the NHS across the UK is £1.06 billion per annum (Davies *et al*, 2011). In England, the loss of productivity attributable to physical activity is estimated to be £5.5bn, and premature deaths £1.1bn (Ossa & Hutton, 2002).

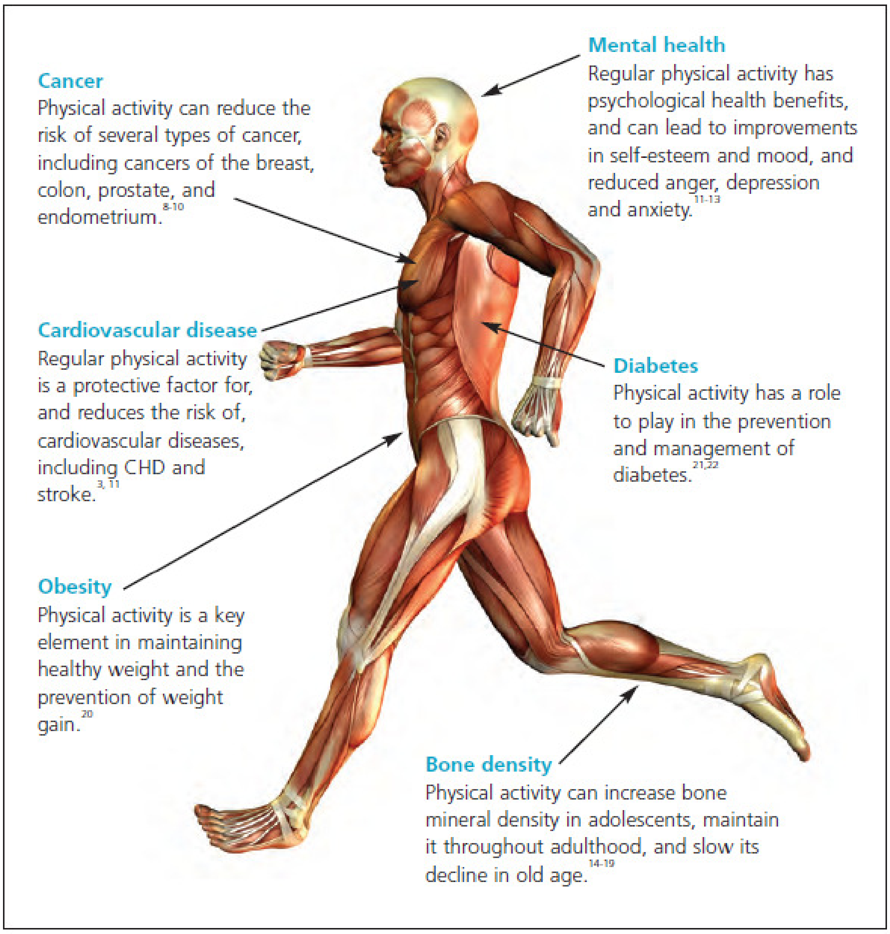

Figure 6 – Summary of health benefits of physical activity (Source: British Medical Association, 2012)

Table 2 – Proportion of population of England in various Body Mass Index categories and trips per head by year by various modes (Source: Mackett & Brown, 2011)

		Men		Women	
		1993	**2009**	**1993**	**2009**
Body Mass Index	% underweight	1	2	2	3
	% normal	41	32	50	40
	% overweight	44	43	32	33
	% obese	13	23	16	24
Trip rates per head	Walk	272	214	311	241
	Bicycle	26	23	11	8
	All travel	1110	947	1064	998

Cycling has a significant advantage over many other physical activities in that it can be integrated into everyday life – whether cycling to work, to school, or to the shops. Cycling uses the large skeletal muscles of the body in a rhythmic pattern, with periods of active work usually alternating with rest periods allowing recovery (Cavill & Davis, 2007). As a result, whether undertaken at a leisurely or more aggressive pace, the rider experiences a net health benefit from cycling.

The health impact of regular cycling is also shown by statistical evidence. Even adjusting for other risk factors, including leisure time physical activity, those who did not cycle to work experienced a 39% higher mortality rate (Anderson *et al*, 2000). EU countries with the highest levels of cycling also tend to have the lowest levels of obesity, diabetes, and hypertension (Pucher & Dijkstra, 2003). Benefit:cost ratios of cycling are overwhelmingly positive primarily due to the significant health benefits of cycling (Bauman & Rissel, 2009).

Accordingly, many health organisations actively support and promote cycling through everyday practice. The British Medical Association (2012) has called for transport to focus on active transport as the top priority to tackle obesity issues. This is supported by the National Institute for Health and Clinical Excellence (2012), who also recommend practitioners promote walking and cycling to patients to tackle existing issues.

Given the significant health benefits of regular cycling, an area of concern for those who argue against cycle helmet laws is the impact such laws have on cycling levels, and thus on overall health. A number of studies have investigated the impacts of compulsory helmet laws on cycling levels in areas where they have been enacted. These studies have typically been population-based, and focussed on regular cycling levels using methods ranging from roadside counts to Census data. Studies reviewed are included in Table 3.

Regardless of the method used to assess impacts of a compulsory helmet law, evidence suggests that should a compulsory helmet law been enacted, a reduction in overall cycling levels of between 20% and 40% is expected.

A limitation of these population-level studies is that many do not control for other environmental factors that may influence cycling levels, such as changes to highway infrastructure. Another limitation is that theses studies have focussed on cycling for a particular purpose, such as commuting or school travel, and do not consider the effect of substitution (de Jong, 2012). Many cyclists may substitute their regular cycling journeys for other physical activities, and as such may still experience a similar level of health benefit as regular cycling.

The consistency of a reduction in cycling levels across a number of areas and methodologies would indicate that cycling levels would be expected to drop in response to compulsory helmet legislation. Considering the wider health benefits of cycling, such reductions would clearly have significant individual and population-level health implications.

Table 3 – Summary of research into changes in cycling levels following the introduction of compulsory helmet laws

Study Area	Study Method	Results	Source
Melbourne, Australia	Cyclist counts and site surveys before and after helmet laws introduced	42% reduction in observed child cyclists 29% reduction in observed adult cyclists	Robinson (1996)
Australia	Percentage of Australians cycling to work before and after the introduction of cycle helmet laws as measured in the Census.	Fall from 1.7% in 1986 to 1.3% in 2011 of percentage of Australians cycling to work	Gillham (2012)
Perth, Australia	Automatic count data taken before helmet laws were introduced and afterwards (October to December in 1991, 1992, 1993, and 1994)	Compared to 1991 levels, a 21% reduction in trips was observed in 1992, 24% reduction in 1993, and 35% in 1994	Robinson (2006)
Various	Use of simple model to estimate the health impacts of compulsory helmet laws, using literature estimates.	Reduce number of cycle trips by between 20% and 40%. Net health benefit only in dangerous cycling environments and minor behavioural responses	de Jong (2012)
Nova Scotia, Canada	Observations to record helmet use, sex, and age of cyclists on arterial, residential, and recreational roads. Sampling undertaken during peak hours in summers and autumns for 2 years before and after cycle legislation.	Decline in number of cyclists of 40%-60% post helmet law. 8% of cyclists were children pre-law, 4% post law.	LeBlanc *et al* (2002)

3. Whether cycle helmets affect the likelihood of an accident

A key factor behind the assessment of the impact of cycle helmets and any associated laws is how these will change the behaviours of both cyclists and non-cyclists in such as way as to alter the likelihood of an accident occurring. Risk compensation is a widely recognised theoretical construct where people adopt more or less risky behaviours in response to an environmental change, such as the use of cycle helmets. Hedlund (2000) sets out four key rules by which behaviour may or may not change:

1. **If I don't know its there, I won't compensate for the safety measure** – Cycle helmets are highly visible for the cyclist and other road users, which may lead to compensating behaviours.
2. **If it doesn't affect me, I won't compensate for this safety measure** – Cycle helmets directly affect the cyclist, which may lead to compensating behaviours.
3. **If I have no reason to change my behaviour, I won't compensate for a safety measure** – A compulsory cycle helmet law may result in cyclists and other road users compensating for this new behaviour.
4. **If my behaviour is tightly controlled, I won't compensate for a safety measure** – Enforceability of the cycle helmet law may result in little or no behaviour change.

Whilst risk compensation has been firmly established as a concept in a number of fields, there are few studies on its application to cycle helmets and the compulsory cycle helmet legislation debate. There are a number of studies which have begun to explore this area.

Based upon qualitative data collected on cyclist and non-cyclist attitudes, Christmas *et al* (2010) conceptualised interactions between cyclists and non-cyclists into 4 groups (Table 4). Cyclists positions in each group is then reflected in their positioning on the highway, and their general attitude whilst cycling. Cyclists may also change between these groups, for example favouring an assertive approach at junctions, but using avoidance when cycling along roads with an adjacent cycle path. Importantly, Christmas *et al* (2010) found that the cycle helmet plays little role in calculating the overall risk of cycling outside of offering 'peace of mind', with other factors such as traffic levels being seen as a greater risk.

Phillips *et al* (2011) investigated risk compensation to cycle helmet wearing by observing changes in participant's heart rates in response to changes in the cycling environment, notably cycling with and without a helmet. This study indicated that there is a significant difference in response by frequent and infrequent cyclists. Frequent cyclists tended to cycle faster whilst wearing helmets, whilst little change was observed amongst infrequent cyclists. Given the known relationships between speed and crash likelihood and severity, helmet compulsion may impact upon crash severity among frequent cyclists.

Table 4 – Four approaches to cycling and positioning strategy when cycling (Christmas et al, 2010)

Group	**Basic Strategy**	**Positioning Strategy**
Avoidance	Avoid traffic completely	Off road wherever possible; left of lane on quiet roads only
Guardedness	Keep out of the way	Consistent use of left-of-centre of lane positioning as default position; may avoid the busiest roads and most challenging junctions.
Assertion	Stay in control of the situation	Consistent use of middle-of-lane positioning to establish position in traffic; bold and well-signalled moves between 'lanes within lanes'
Opportunism	Make the most of the bike	Situational judgment of which position best balances needs against risks

It is also theorised that the presence of a cycle helmet on a cyclist changes the risk compensation of other road users. In a well-known study, Walker (2007) used ultrasonic distance sensors to detect how close 2,300 vehicles passed in response to a variety of factors. This study found that drivers both passed and approached helmeted cyclists much closer than those not wearing a helmet. Walker (2007) states that this may support other research that suggests drivers tend to believe helmeted cyclists are more serious, and are less likely to make mistakes. This perception is against the fact that less experienced and confident cyclists are more likely to wear helmets than most other cycling groups.

Initial studies into risk compensation and cycle helmets have shown that there could potentially be linkages between cycle helmets and the risk behaviours of cyclists and other road users. However, a lack of studies of a suitable sample size means that further work is required in this area to determine the scale of the impacts of cycle helmets and helmet compulsion laws on risky behaviour.

The nature of the debate

An observation of the general nature of the cycle helmet debate is that opposite sides seeks to frame the debate in different ways. For those who are pro-helmet laws, the fundamental issue is that if a cyclist is involved in an crash, and if they hit their head, if the cyclist is wearing a helmet there is lower risk of being killed or seriously injured – for which there is strong supporting evidence. People who are opposed to cycle helmet laws approach the debate in terms of the processes prior to the crash, particularly with an interest in overall cycling levels, where the same helmet laws show a reduction in overall cycling levels.

Initial research into risk compensation theory and cycle helmets suggests the presence of a helmet can influence the behaviours of some cyclists and other road users in a way that may encourage more risky behaviour. This evidence is highlighted by those opposing cycle helmet legislation as a key risk. This may be the case, but the lack of studies of sufficient sample sizes means we cannot draw any definitive conclusions without further study.

There is a reasonable level of evidence to support both viewpoints in this debate. To inform decision making for transport professionals there is a need to determine whether a compulsory helmet law would be of a net health benefit, and thus be a good transport policy option.

Potential impacts of a compulsory helmet law in the UK

The assessment will assess the health impacts in terms of the changes to the number of premature deaths, or lost life years, associated with the loss of physical activity (regular cycling) and changes in cycle fatalities in road traffic crashes. Using the number of fatalities as a proxy for net health benefit has a number of data advantages, notably the lower uncertainty of data recording (DeMarco, 2002), and its consistency across a wide variety of datasets and different settings.

In reality, the health impacts of cycling go beyond fatalities. Changes in the number of cyclists killed and seriously injured are most notable, and compulsory helmet legislation is likely to have an effect upon this either through changes in the use of cycle helmets or changing cycling levels. Similarly, changing cycling levels is likely to impact upon quality of life through changes in risks of developing health problems or illnesses, many of which are non-fatal. These potential impacts are accepted, however the collection of data on these is either lacking, inconsistent, or subject to bias within the collection method. For example, what may be considered to be a slight injury in a cyclist accident in one area may be considered to be a serious injury in another. With fatalities, the risk of this inconsistency is much reduced.

It is also worthwhile highlighting fatalities from cycling deaths in road traffic collision data and premature deaths from reduced physical exercise are slightly different. For cyclist fatalities from road traffic crashes it is relatively simple – a person or persons killed in the event of crash. For premature deaths, this is in terms of lost “life years” from the increased risk of developing medical conditions resulting from lower rates of physical activity, averaged across the whole population. This is reflected in the age profile of accidents, where 46% of cycle fatalities are aged between 25-54 years old (Keep, 2012), whereas premature deaths cover an age range up to 75 years old. The implications of this variation, particularly in terms of the economic impacts of changing cycling levels, are factored into the chosen method.

Premature deaths owing to loss of physical activity

To assess the population-level impacts of a compulsory helmet law on premature deaths owing to a loss of physical activity, i.e. less cycling, the World Heath Organisation’s Health Economic Assessment Tool (HEAT) for Cycling was utilised. This tool estimates the economic benefit resulting from reductions in mortality as a consequence of regular walking and cycling. It seeks to determine if X people walk or cycle Y distance on most days, what is the economic value of mortality rate improvements? (World Health Organisation, 2012). The parameters and estimates contained within HEAT are based upon the best available evidence on the impact of regular walking and cycling upon health at a population level, with users being required to input their own data as required.

HEAT can be used in a variety of circumstances, with one of its key strengths being to estimate the current economic benefit of existing cycling levels, and the economic benefit or cost of changes in cycling levels. This includes estimating the number of fatalities prevented by such cycling levels. With the quality of evidence, and peer-reviewed and tested nature of the tool, it is an ideal tool for estimating the impacts of changes in cycling levels owing to a compulsory helmet law.

Parameters

The full parameters included as part of the HEAT assessment are detailed in Table 5. The key parameters for the assessment are:

Number of cycling trips per day:

The average annual number of cycle trips per person per annum was utilised from the National Travel Survey for the years 2006 to 2010 – the largest and most consistent dataset on national travel trends for the UK population. During this period, the average number of cycle trips per person has maintained a remarkable consistency (Figure 7), partly explained by cycling making up a small proportion of total trips – around 1.5% of trips. Whilst giving a good indication of cycling at the population level, this does hide significant variations among key population groups, for example young people tend to cycle more. For the purposes of the HEAT assessment, an average of the trip rates across the 5 years was taken.

Number of cyclists:

The data from the National Travel Survey used to calculate the number of cycling trips per day has been aggregated across the population of the UK. Therefore the number of cyclists has been taken as the population of Great Britain as defined in the 2011 Census. Again, this masks significant variations in cycling among key population groups.

Trip distance:

Average distances of cycling trips was utilised from the National Travel Surveys for the years 2006-2010. Much the same of the number of cycling trips, the average trip distance by bicycle has remained consistent over this period (Figure 8), with the average distance of these 5 years used for the HEAT calculation.

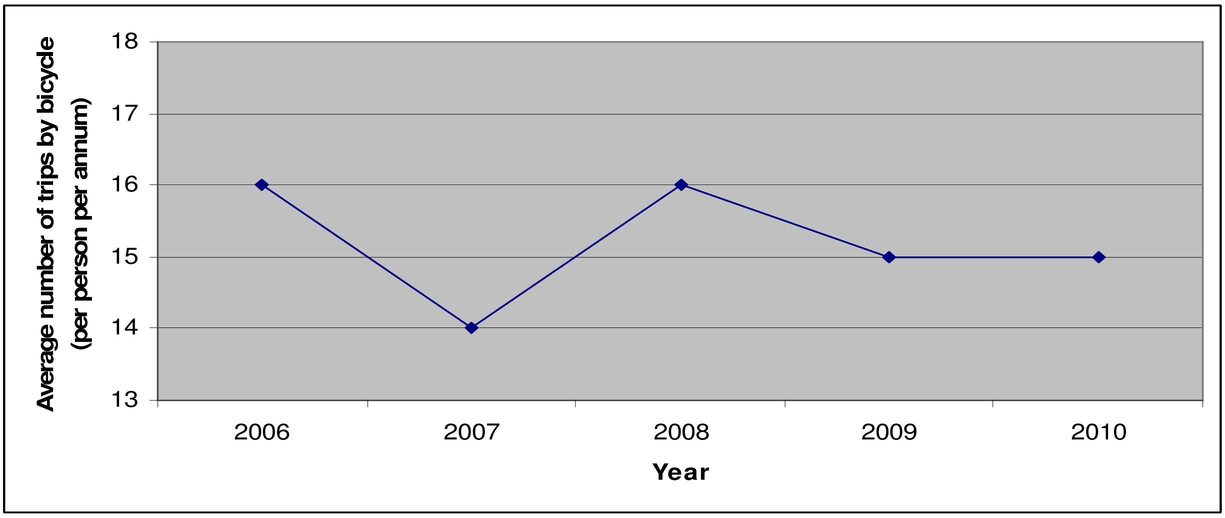

Figure 7 – Average number of cycling trips per person per annum between 2006 and 2010 (Source: Department for Transport, 2011)

Table 5 – Parameters included as part of HEAT assessment, including sources

Data	Calculations	Figures	Source(s)
Cycling Trips	(Average number of trips per person per annum (2006-2010) x Number of cyclists) / 365	Current level of cycling trips = 2,554,046 per day 20% reduction in cycling trips = 2,043,237 trips per day 40% reduction in cycling trips = 1,532,428 trips per day	National Travel Survey data from 2006-2010
Number of cyclists	Total number of individuals	UK population = 61,330,712	Census 2011 for England and Wales 2011 Mid Year Population estimates for Scotland
Number of days cycling	Number of days per year	365	-
Trip Distance	Average trip length of all cycle trips (2006-2010)	2.7 miles	National Travel Survey data from 2006-2010
Mortality Rate	Default HEAT value for the UK	253.63 deaths per 100,000 population	Default HEAT value for the UK
Value of a Statistical Life	Default HEAT value	€1,574,000	Default HEAT value
Time period over which benefits are calculated	Time period for which data on cycling trips is available	5 years	HEAT recommendation to use time period over which data on cycling trips is available.
Discount rate	3.5%	None	Department for Transport (2011) *Transport Appraisal and the Treasury Green Book*. London. The Stationary Office
Proportion of changes observed attributable to intervention	Assumes that no other major cycling interventions above existing commitments are made	100%	-

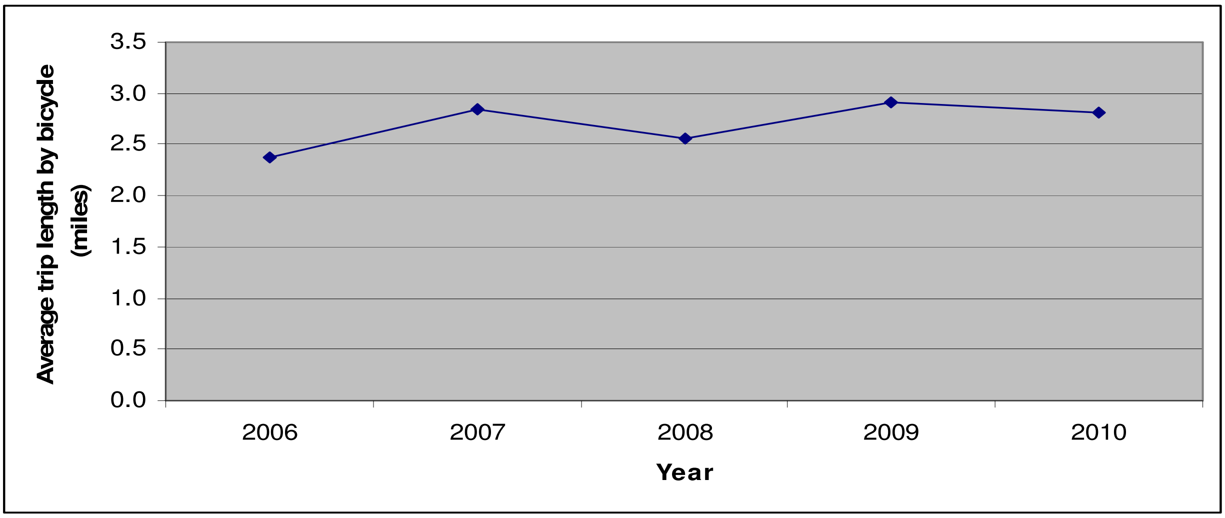

Figure 8 – Average length of cycling trips in miles (Source: Department for Transport, 2011)

Scenario Testing

The key parameter forming the basis of the scenario testing is the number of cycling trips per day, and how this changes in response to compulsory helmet laws. As shown in Table 3, significant variations in reduced cycling levels have been observed across a number of studies, so adopting a single figure to use for this assessment is tricky. Regardless, the results of these studies indicate a range of reductions of between 20% and 40% in observed cycling trips. HEAT also recommends using higher and lower estimates of the main variables as a sensitivity analysis.

The health benefits of current cycling was estimated using HEAT to form the base, known as the 2006-2010 Base. This base is used to assess the impacts of two different scenarios:

1. 20% reduction in daily cycling trips
2. 40% reduction in daily cycling trips

The reductions observed in the existing literature may not be directly applicable to the UK situation due to local cycling environment differences, legislative context, and attitudes to cycling. Also, the data that informs the HEAT tool calculations is mostly based upon studies of the adult population (World Health Organisation, 2012), so applying results to child populations may be anomalous. Regardless, the outcome of this assessment is estimate of the potential health economic changes arising from changes in helmet law, based upon the best available research, and as such is a robust method.

For the base and each scenario, HEAT produces two outputs: the number of deaths per year that are prevented by this level of exercise, and the average annual economic benefit (discounted).

Cycle fatalities in road traffic crashes

The number of cyclists killed per annum in road traffic crashes in the UK is provided by police reports recorded on STATS19 forms. STATS19 collects a variety of data on crash circumstances, persons and vehicles involved, and contributory factors. STATS19 data is the only national data source to provide this level of detail for crashes for a lengthy period of time. To maintain consistency with the HEAT assessment, an average of annual cycling fatalities from road crashes for 2006-2010 was taken from the STATS19 data, known as the 2006-2010 Base.

The impacts of a compulsory cycle helmet law was then applied based upon two scenarios as reflected in Hynd *et al* (2009):

1. 10% reduction in total observed cyclist fatalities
2. 16% reduction in total observed cyclist fatalities.

This range was chosen owing to its application to the UK context, and the focus of the majority of the other literature on child head injuries and fatalities. The Hynd *et al* (2009) estimate is not without its flaws. Notably, it relies upon a cycle helmet wearing rate of 100% post-compulsory helmet laws, and is heavily influenced by data from London. However, it is the best estimate available that is applicable to the UK cycling environment.

To provide a comparison of the economic costs with the HEAT assessment, the total number of cycle fatalities in the baseline and two scenarios was multiplied by the current average value of prevention per reported road casualty. This cost is £1,686,532 per fatality (Department for Transport, 2012).

Results

The impacts of a compulsory helmet law on deaths prevented by cycling levels and cyclists fatalities from road traffic are shown in Tables 6 and 7 respectively. These results are then cross-tabulated to identify a range of impacts, both in terms of fatalities and economic costs, of a compulsory helmet law in Tables 8 and 9.

Table 6 – Changes in deaths per year prevented and health economic benefits of cycling as a result of changes in levels of cycling estimated from the introduction of compulsory helmet legislation in the UK

	Deaths per year prevented by this level / change of cycling (change from base)	**Health economic benefit of level / change of cycling per annum (change from base)**
2006-2010 Base	2,216	£2,788m
20% reduction in cycling levels	2,657 (-441)	£2,900m (-£112m)
40% reduction in cycling levels	3,099 (-883)	3,012m (-£224m)

Table 7 – Impact of compulsory helmet legislation on pedal cyclist fatalities in the UK per annum

	2006-2010 Base	Scenarios on reductions in total observed cyclist fatalities	
		10%	16%
Pedal cyclist fatalities (per annum)	122	110 (-12)	103 (-19)
Economic cost (per annum)	£200m	£180m (-£20m)	£168m (-£32m)

Table 8 – Estimated combined impact of compulsory cycle legislation on fatalities in the UK per annum (Total Population)

		Change in deaths per year prevented by cycling levels	
		20% reduction in cycling levels	40% reduction in cycling levels
Change in pedal cyclist fatalities from road traffic crashes	**10% reduction**	+429	+871
	16% reduction	+422	+864

Formula used: Change in deaths per year prevented by cycling levels – Cycle fatalities from road crashes

Table 9 – Estimated economic impact of compulsory cycle helmet legislation in the UK per annum (Total Population)

		Change in economic benefit of cycling levels	
		20% reduction in cycling levels	40% reduction in cycling levels
Change in cost of pedal cyclist fatalities from road traffic crashes	**10% reduction**	-£92m	-£204m
	16% reduction	-£80m	-£192m

Formula used: Change in economic benefit of cycling levels + change in cost of pedal cyclist fatalities from road traffic crashes

It is estimated that current cycling levels in the UK prevent around 2,216 premature deaths per year from various health issues, with an economic benefit of around £2.8bn per annum. It is notable that under all circumstances, the estimated impact of a compulsory helmet law is to increase the total number of deaths, from between 422 and 871 deaths per annum. This would be of a net economic cost of between £80 million and £204 million.

These results give significant weight to the argument that the much wider benefits in terms of healthier lifestyles the associated reduced risk of illness and premature death are more significant than the costs associated with cyclist fatalities on UK roads. Such is the scale of the impacts of reduced physical activity from reduced cycling levels estimated in this assessment, even if every cyclist fatality recorded by STATS19 was saved by a helmet law, the law would still result in more premature deaths than road fatalities saved.

The effectiveness of a compulsory helmet law is dependent upon a number of different factors. de Jong (2012) highlights that the efficacy of helmets, behavioural responses of cyclists to the law, and the current proportion of cyclist fatalities resulting from head injuries. MacPherson *et al* (2001) also highlights the importance of enforcement of any such laws in their effectiveness.

A key area that has not formed part of this assessment, largely due to a lack of population-level studies and data, is the impact of cycling risk strategies and how helmets impact upon the perception of cycling as a safe activity. Cyclists exhibit a range of behaviours and these affect either the level of risk they take, the level of risk imposed on them (Hewson, 2005), and their risk avoidance strategies. There is evidence that certain population groups are more likely to wear helmets (Gregory *et al*, 2003), so individual judgements of the relative safety benefit of helmets will be a feature of populations who choose not to wear them, whether cycling or not. Compulsory helmet laws may, in turn, impact upon this perception of cycling risk.

It also needs to be stressed that this analysis has been undertaken at a population level. We cannot therefore assume that aggregate-level relationships will be the same as those observed at the individual level. Indeed, this is a very well understood statistical phenomenon. Regardless of this, the conclusion cannot be escaped that from the best current evidence available, a compulsory helmet law would lead to an overall increase in premature deaths.

Summary and Conclusion

The current debate on the efficacy of cycling helmets, and the potential impacts of a compulsory helmet law, can best be described as a heated one. This is partly because both sides attempt to frame the debate in different ways. Those who favour helmet legislation and promote the effectiveness of helmets as a safety device focus on its benefits in the cases of crashes where there is an impact with the head. Whilst there is evidence that indicates that cycle helmets reduce the risk of injury in such crashes, head injuries only occur in 39.8% of serious or fatal crashes. The best UK estimates indicate that between 10% and 16% of cyclist fatalities could have been prevented by cycle helmets, with significant reservations over the methods used.

For those who consider that wearing cycle helmets should remain discretionary, the main issue is the impact of compulsory helmet laws on cycling levels and the corresponding health implications. The health benefits of cycling as a physical activity are well documented and proven, and international evidence suggests that compulsory helmet laws will reduce cycling at a population level. Initial research has indicated that a compulsory helmet law may lead to more risky behaviour from both cyclists and other road users, however a lack of studies with sufficient sample sizes means no firm conclusions can be made on this at this stage.

An assessment of the impacts of a compulsory helmet law on fatalities associated with cycling was undertaken, based upon the best available evidence showing the impact of said legislation on cycling levels and fatalities in road traffic crashes. The results of this assessment were clear: even if compulsory helmet legislation reduced cyclist road traffic fatalities to zero, this is more than offset by the increases in population-level premature deaths associated with reduced physical activity.

This is not to say that cycle helmets have no role for safety at the individual level. Individuals may subjectively feel that wearing a cycle helmet offers them a level of protection that provides them with piece of mind whilst cycling. This may be the case even if, scientifically, the helmet would offer them little or no protection in the event of a crash.

This paper sought to assess the impacts of compulsory cycle helmet legislation should it be applied in the UK. It provides estimates that compelling cyclists to wear helmets by law is likely to both reduce cycling levels, and lead to more premature deaths than the legislation would save. Transport professionals now have a much wider health and safety remit than simply reducing the number of road crash casualties. If transport professionals wish to save the lives of cyclists, our focus should be on other measures that will encourage more people to cycle by making the bike a safer and more attractive transport option.

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