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Aldred, R.

Transportation Research Part A 90 (2016) 69–83

Contents lists available at ScienceDirect

Transportation Research Part A

journal homepage: www.elsevier.com/locate/tra

Cycling near misses: Their frequency, impact, and prevention

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ARTICLE INFO

Article history:
Received 27 May 2015
Received in revised form 26 April 2016
Accepted 29 April 2016
Available online 15 June 2016

Keywords:
Cycling
Risk
UK
Near misses
Danger reduction
Injury

ABSTRACT

This paper explores cyclists' experiences of non-injury incidents, arguing that these are important for cycling experience and uptake as well as for injury prevention. It discusses different types of non-injury incident collected in a recent survey of UK cyclists. These are everyday occurrences that in some cases have a substantially negative impact on cycling experiences. This article explores the impact of different incident types on people cycling both immediately and in the future. It analyses what near misses tell us about cyclists' experience of problems related to road user behaviour and culture, and infrastructural conditions for cycling. The paper explores what cyclists experiencing near misses think might have prevented them. Based on this and on a comparison with common types of injury incidents, summary recommendations are made for policy and future research.

1. Introduction

This paper discusses findings from a project exploring experiences of cycling near misses. Given policy goals to grow cycling from a low base (Aldred, 2012) near misses are doubly important. Firstly, they may predict types of behaviour and/or road infrastructure that commonly lead to injury. Secondly, they may negatively affect cycling experience and uptake. However, near misses are under-researched in road transport literature and data not routinely collected. The study reported here is the first national UK survey to collect data on cycling near misses allowing the calculation and comparison of per-mile and per-hour rates.

In this survey participants described non-injury incidents happening during a day's cycling, their reactions to these, and factors they thought might have prevented incidents. A previously published article (Aldred and Crosweller, 2015) outlined 'headline' statistics for incident rates and types. This paper discusses in more detail impacts of incidents and how cyclists react to them, including new analysis of qualitative and quantitative data. Covering the impact on cyclists of problematic behaviour and infrastructure, it explores what the UK 'road culture' feels like from a cyclist's perspective.

The paper considers ways of preventing and reducing the most problematic 'near miss' incidents. It draws on cyclists' own views, and on a perspective within which 'behaviour', 'culture', and 'infrastructure' are seen as inter-related. This approach sees driver (and cyclist) behaviour as shaping the impact of infrastructural changes, and conversely, infrastructural changes as having the potential to affect culture and behaviour. More broadly, the paper seeks to demonstrate the utility of an experiential perspective on cycling risk.

2. Literature overview

This paper contributes to literature about cycling risk, through an experientially-focused perspective. Centrally, much literature highlights the apparent discrepancy between 'perceived' and 'real' risks and benefits of cycling. Even in

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http://dx.doi.org/10.1016/j.tra.2016.04.016
0965-8564/

low-cycling contexts, much evidence demonstrates pleasurable and positive cycling experiences (e.g. Zander et al., 2013). However, this exists alongside substantial 'fear of cycling' (Horton, 2007; Gamble et al., 2015): the mode is seen as inherently unsafe. This is expressed in policy debates and appraisal tools (Roberts and Coggan, 1994). For example, cost-benefit analysis generally attributes risk of cycle injury to cycling, but this should arguably be attributed to driving (Gössling and Choi, 2015).[1]

However, in UK policy and academic cycling discourse, a view of cycling as risky persists alongside a more recent tradition of focusing on multiple benefits of cycling (Aldred, 2012). An oft-quoted, albeit questionable (Woodcock et al., 2014) statistic suggests health benefits outweigh risks to the individual by 20–1 (Hillman, 1993). The two discourses co-exist, with many people believing cyclists are healthy and fit, yet also dangerous risk-takers (TfL, 2014; Aldred, 2013). This has fed into an association of cycling with some demographic groups (primarily younger professional adult men) and not others (Steinbach et al., 2011).

Why do many lay people think cycling is so dangerous? Are they misinformed? The approach to risk taken here draws on sociological and psychological perspectives, increasingly influential in broader risk analysis (Taylor-Gooby and Zinn, 2006; see e.g. Slovic, 2000). These perspectives do not see divergences between expert and public views about risk as implying the public must be wrong. Indeed, growing evidence suggests people are relatively good at comparing situation-specific cycling risks, their judgements corresponding reasonably well to expert opinion (e.g. Bill et al., 2015; Doorley et al., 2015; Johnson et al., 2014; Sanders, 2013). At the same time, many see on-road cycling in the UK as unacceptably risky (DfT, 2014).

The approach taken here suggests that while risk perceptions are influenced by media and safety campaigns, lived experience – participation, interaction and/or observation – is also crucial. Although at any given time UK cyclists are a small minority, cycling experience is not limited to current cyclists. People increase or decrease cycling from year to year, and move in and out of cycling (TfL, 2014). Many people know a cyclist, even where cycling levels are low,[2] and so may regularly hear about cycling experiences, which can be important in shaping attitudes to transport (Kamargianni et al., 2014). People also draw conclusions about the comfort, status and safety of cycling from observing cyclists (Pooley et al., 2013; Aldred and Woodcock, 2015).

Related local research has indicated the potential importance of near miss incidents in cycling experience. Joshi et al.'s pioneering near miss study in Oxford (2001) found cyclists' experience of near misses was frequent and in line with their higher relative injury risk compared to drivers. More recently, Sanders (2015) study in the San Francisco Bay Area suggests the frequency of near misses leads to a greater impact on perceived danger than injury collisions. Building on such research, this study analyses what are demonstrated to be frequent occurrences in the UK context, considers their impacts and strategies to prevent them. It argues that cycling near misses, as regular events, contribute to perceived cycling risk as understood by current cyclists, and potentially through more indirect processes whereby others hear about or see such incidents.

3. Methods

The study reported here used an online diary method, with ethical approval granted by Westminster University. A convenience sample of people who cycle was recruited. Channels included organisational mailing lists, cycling organisations, leafleting, social media dissemination, and re-contacting previous survey participants. The call to participate was covered in the *London Evening Standard*. Participants were informed that the study focused on cycling near misses and that it should take around 15–20 min to complete. They were asked to nominate in advance a day over a two-week period to record cycle trips and any incidents.

Organisations independently shared information about the project via social media, as tends to happen with online research of this sort. This necessarily reduced control over how the study was described. For example, a tweet was sent on 14th October 2014 by the national organisation *British Cycling*, whose publicity generated several hundred sign-ups:

Are you a cyclist concerned about your safety on the roads? Check out this project and do your bit to help nearmiss.bike.

The recruitment method could introduce bias, if people more prone to near misses sign up. However, given only 2% of trips are by cycle, using more traditional methods to recruit a national sample of cyclists would be difficult and expensive. The study sought to ensure different types of cyclist were represented by using a range of recruitment channels and messages. Another attempt to reduce bias was to remove those reporting many incidents (>10) as potential outliers, with unusually high rates of/awareness of non-injury incidents.

Each diary asked participants to report all cycle trip stages, without exact location details: this might include 'Home to Work', 'Work to Meeting', for example. They were asked for timings of each trip stage, and an estimate of total distance travelled and their confidence of this. Many were reporting a repeated journey (typically, commute) while others used apps such as Strava, so confidence was generally high. Respondents were asked whether any non-injury incidents occurred, and if so, to locate the incident on a Google map. People could leave and return to the survey; often reporting morning trips and any incidents at lunchtime, completing the diary that evening or next morning. We piloted concomitant use of a GPS tracking app

[1] In the UK around four-fifths of deaths and serious injuries reported to the police result from collisions with motor vehicles (Knowles et al., 2009).
[2] For example, half of all Londoners. Source: personal communication from TfL related to London Travel Demand Survey data.

but decided against this because of the impact on response rates, so we cannot calculate exposure-based risks by infrastructure type.

The definition of 'incident' was open, with participants directed to record events they found annoying and/or frightening. They were asked to separately rate how scary or annoying incidents were; where on each scale 0 represented 'not at all scary' or 'not at all annoying' and 3 'very scary' or 'very annoying'. They described incidents and locations in free text fields, and were asked whether the incident could have been prevented, and if so how and by whom or what. They were asked how an incident had make them feel, and whether and how it would affect their future cycling. All were asked for comments on cycling (where many highlighted positive as well as negative experiences) and for basic demographic and locational information.

Analysis involved various stages, including cleaning and coding data, using Excel, SPSS and NVivo. First, non-UK incidents were removed, as were several hundred classed as either reported in error or as, for example, witnessed rather than directly experienced. This produced a dataset containing 4662 incidents. 96.7% (1596) of those participants experienced between 0 and 10 incidents (84.9% experienced 0–5 incidents). We removed 55 people who recorded over 10 incidents (maximum = 55) as outliers.[3] Nine more participants were removed due to incomplete data. Hence the following analysis relates to 1532 UK-based diaries (1525 diarists, as seven completed two diaries) and 3994 incidents. Around 60% of those who initially registered fully completed the diary.

Analysis reported in a first paper (Aldred and Crosweller, 2015) used regression modelling to identify factors contributing to near miss rates and incident scariness. This paper builds on that work, combining qualitative with quantitative analysis. Coding strategies varied depending on the data and its role within analysis. For example, in looking at what road changes cyclists said might prevent incidents, coding was inductive and initially produced many specific codes. These were combined based on categories used in transport planning; for example, 'traffic calming' as a parent node to codes covering topics such as speed reduction, filtered permeability and lane narrowing. Automatic coding complemented manual coding; for example, word frequency searches were used to start categorising impacts. Categories created in NVivo were exported for re-analysis in SPSS. Therefore, it is possible, for instance, to examine types of preventative strategies recommended in relation to factors important in determining incident rates.

4. Results

4.1. People and incidents: summary

Participants were disproportionately male (72.1%), reflecting the gender balance of UK cycling. The age distribution was skewed towards the middle years, with two-thirds aged 35–44. By comparison, only a quarter of English and Welsh cycle commuters fall within that age bracket (ONS, 2014). Regression modelling conducted in Aldred and Crosweller (2015) established age had a very weak effect on incident rates: these declined slightly for older cyclists. Most participants lived in England or Scotland, with almost a third living in London; but we found that living in London or not made no difference to overall incident rates (Aldred and Crosweller, 2015).

Most (92.0%) were weekday travellers, often commuting, with weekend participants tending to make longer, leisure-focused trips. Although journey purpose was only gathered indirectly using free text fields, 69.5% explicitly indicated "work" as a destination, including 74.9% of weekday travellers (compared to 5.8% of weekend travellers).

As shown in Table 1, distances travelled are long, even given people are likely to be indicating actual road network distances. This highlights (a) a weekend sample comprised largely of touring cyclists and (b) the skewing of the weekday sample towards longer distance commuters and, probably, more experienced cyclists. This limits the study: it is likely that near miss incidents have greater impacts on newer cyclists, including potentially their stopping cycling. The survey is unable to capture this.

Dividing number of incidents by total distance (or time) generated a rate of 0.172 incidents per mile or 1.82 incidents per hour (Aldred and Crosweller, 2015). Over two-fifths were 'very annoying' and one in seven 'very scary'. Regression modelling established that the main contributor to incident rates was the speed (derived by dividing self-reported distance by time) at which the cyclist completed their journey. Although living in London made no difference to reported rates, types of incident reported differ between London, other urban, and rural areas. These to some extent seem to correspond with differences in causes of cyclist deaths; a greater proportion of left hook incidents in London, for example (c.f. Talbot et al., 2014).

Although the area is under-researched, results can be compared to other similar studies. Joshi et al. (2001) used more traditional recruitment methods, finding similar incident rates per mile (Aldred and Crosweller 2015), and Walker et al.'s (2014) objectively recorded close pass rate per mile (see below) is similar to that calculated here. Hence, while headline rates seem high, other studies corroborate the broader picture.

4.2. Types of incident

This section discusses types of incident, their impacts and how they relate to injury collisions.

[3] Also, full data on incidents was only collected for the first ten incidents.

Table 1
Distance travelled.

	Weekday	Weekend
N (cyclists)	1412	120
Mean (miles)	14.0	29.2
25th percentile (miles)	6.8	12.6
50th percentile (median; miles)	11.5	22.7
75th percentile (miles)	18.0	44.0

4.2.1. Summary

Incident descriptions were categorised into eight different headings. The most frequent types, in descending order, were a cyclist's way being blocked (often necessitating swerving), a problematic pass, and a vehicle pulling in or out across a cyclist's path. Together those represented over 80% of incidents. The table below demonstrates that incidents can be divided into two broad types in terms of how scary they are; blocking plus a much smaller number of 'other' incidents form around 40% of the dataset, and are relatively unlikely to be 'very scary'. Other listed incident categories, most commonly problematic passes, are all much more likely to be 'very scary'. A regression model estimated in Aldred and Crosweller (2015) confirmed the association of specific incident types with higher levels of 'scariness', alongside the involvement of motor vehicles, particularly larger vehicles (see Table 2).

The relationship between how annoying, and how scary an incident was is illustrated below. A Spearman rank correlation test found a correlation of 0.308 ($p < 0.05$).

It can be seen that for the likelihood of an incident being 'very annoying' increases as the scariness increases. However, incidents are diverse: nearly a fifth (18.8%) of incidents are only mildly scary (0 or 1), yet very annoying (3) (see Fig. 1).

4.2.2. Blocking incidents

BLOCK involved multiple types of situation. With the exception of cyclist-pedestrian conflicts,[4] none are well covered in academic and policy literature. Nearly half of BLOCK incidents involved road or infrastructure-related problems; for example, swerving to avoid a pothole or a barrier across a cycle path. Over a quarter involved an interaction with a pedestrian where, typically someone walked in front of a cyclist. Less common types of blocking incident involved motor traffic (e.g. cyclist blocked from joining a road: 8.4%), stopped motor traffic (parked or loading: 8.4%), the blocking of an Advanced Stop Line (ASL; 4.6%) or being obstructed by another cyclist (2.9%).

Blocking incidents were relatively unlikely to be 'very scary', but relatively likely to be 'very annoying'. Among the above subcategories, those most likely to be judged 'very annoying' were being blocked by stopped or moving motor traffic (42.9% and 43.3% respectively). By contrast, being blocked by a pedestrian (despite it typically involving someone stepping directly in front of a cyclist) was only judged 'very annoying' in 31.8% of cases, and being blocked by another cyclist in only 23.3% of cases. While individuals expressed anger and annoyance with pedestrians and other cyclists, their behaviour was on average viewed as less annoying than that of drivers.

4.2.3. Passing incidents

Other incident types were more homogenous, especially 'passing' incidents. These very common incidents tended to involve a motor vehicle (rarely, another cyclist) on a link section overtaking too closely. They were relatively likely to be 'very scary' and frequency suggests experiencing one such incident on alternate days' cycling is normal in the UK. While 'hooking' incidents involving large vehicles are high profile and comprise a high proportion of London cyclist deaths (Talbot et al., 2014) overtaking incidents also kill and seriously injure. McCarthy and Gilbert (1996) report that 21.8% of cyclist deaths recorded in London between 1985 and 1992 involved a motorist overtaking a cyclist. Across the country Stats19 data suggest that close passes are implicated as contributory factors in 19% of collisions killing a cyclist (Knowles et al., 2009).

4.2.4. Other incident types

The third most common category of incident involved a vehicle pulling out or in across a cyclist's path. Some took place at junctions; others along link sections; such as buses pulling into stops, or taxis pulling out. One frequently reported situation involved a motorist pulling out of a side road into a cyclists' path, a classic injury situation (Knowles et al., 2009).

A fourth type of incident involved being driven (occasionally cycled) at. Characteristically, this happened on narrow, parked up residential streets, or single-track country lanes, where a driver expects a cyclist to give way. While relatively scary, these incidents may not indicate increased injury risk, and so differ from other frightening incident types. Vandenbulcke et al. (2014) found that contraflow cycling decreases injury risk, despite potentially creating head-on conflicts, while the City of London Authority has safely introduced contraflow cycling on many narrow one-way streets.[5]

[4] In relation to this study, such conflicts were less frightening and annoying for cyclists (and less numerous) than conflicts with motor vehicles; hence a focus on the latter.

[5] http://www.cityoflondon.gov.uk/services/transport-and-streets/getting-around-the-city/Pages/contra-flow-cycling.aspx.

Table 2
Incident frequency and 'scariness'.

Category	Description	Number	Percent of all incidents	Percent of incident type judged as 'very scary'	Approx. frequency, annual[a]
BLOCK	Cyclist's way blocked	1506	37.7	6.2	170
PASS	Problematic pass (usually too close)	1169	29.3	22.0	130
PULL	Vehicle pulls out or in across cyclist	644	16.1	16.4	70
DRIVEAT	Person drove (or cycled) at cyclist head on	255	6.4	17.3	30
HOOK	Road user turns across cyclist's path	215	5.4	22.0	25
OTHER	Other incident	107	2.7	7.5	10
TAILGATE	Tailgates cyclist without passing	72	1.8	18.1	<10
DOOR	Opens car door in cyclist's way	26	0.7	23.1	<10
		3994 (total)	100 (total)	14.4% (mean)	450 (total)

[a] Assuming a regular commuting cyclist, riding 2500 miles per year.

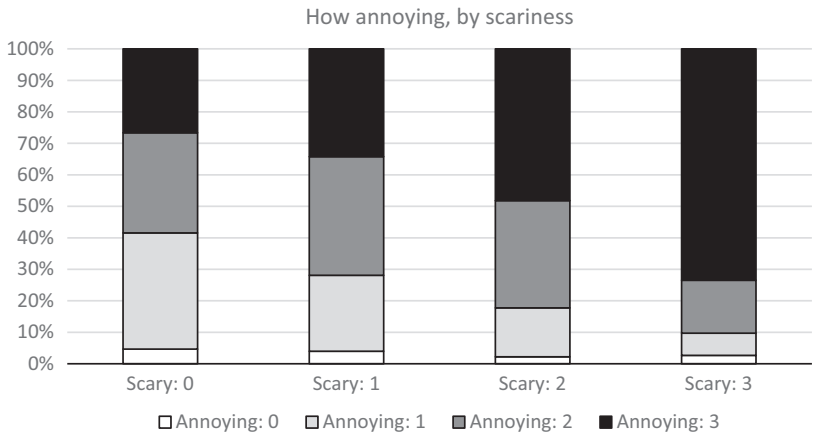

Fig. 1. Annoyingness and scariness of incidents.

Slightly less common – around one in twenty – were hooking incidents, with a cyclist in potential conflict with (usually) a left turning motor vehicle. These, with dooring and passing incidents, were the only three categories where over one in five was 'very scary'. The relatively low proportion of 'hook' incidents contrasts with their more frequent appearance within city injury and death statistics. Around a third of recent London cyclist deaths were caused by a motor vehicle turning left across a cyclist's path (Talbot et al., 2014). Being driven into from behind or while travelling alongside (potential outcomes of a close pass) were by contrast responsible for one in five cycle deaths (comparable with McCarthy and Gilbert's 1996 figure for 'overtaking' deaths).

4.3. Reactions to incidents

The findings here report on analysis of qualitative data from the study. They provide additional material to explore an experiential perspective on cycling, with detail about immediate reactions, future behaviour, and incident prevention.

4.3.1. Immediate reactions

As well as being asked to rate incidents as 'annoying' or 'scary' on a scale from 0 to 3, respondents were asked to describe how incidents made them feel. Excluding 'annoyed' and 'frightened' (as in a sense primed), the top four descriptions (each with over 150 spontaneous mentions) were 'angry', 'frustrated', 'irritated' and 'vulnerable'. Descriptions eloquently expressed how incidents could be simultaneously frightening and mundane, for example:

'My heart stopped. But this happens every time. This is a terrifying interchange for cyclists.'

4.3.2. Future behaviour

People were asked whether an individual incident would affect future cycling, and if so, how. Responses were coded inductively, initially creating many codes which were then combined. The question was only answered by a minority so percentages below are low (see Table 3).

For the seven selected highlighted reactions, the following sections illustrate example quotes and provide brief explanation:

Table 3
Effect on future cycling.

How it will affect future cycling: reactions mentioned in relation to at least ten incidents	Incident type	
	Not 'very scary' (daily, on average), %	'Very scary' (weekly, on average), %
Will be more vigilant/cautious/alert	3.2	9.0
Will take primary position more, blocking overtaking	1.8	4.0
Will find cycling more unpleasant, e.g. paranoia, fear	0.8	3.7
Will attempt to change route	1.6	3.1
Will just have to live with it/expect it to happen again	2.1	2.8
Will stay back/hang back/get out of the way	0.8	2.8
Will use more technology e.g. air horn, daytime lights	0.1	2.1
Will be less likely to cycle in future	0.6	1.7
Will take evasive action, e.g. around potholes	0.8	1.2
Will pay more attention to pedestrians	0.6	0.7

4.3.2.1. Vigilance. Being more vigilant, cautious or alert was mentioned over 150 times. Many said that they already took great care while cycling:

'I already approach this junction, and indeed every portion of the campus where I have to cycle on the road, with considerable caution. I can only attempt to cycle even more cautiously in future.'

'An accumulation of these events over the years has made me super cautious, and I now believe it's not sufficient simply to obey the rules to stay alive. To stay alive one must also anticipate that all others will be careless.'

4.3.2.2. Negative emotions. Comments about vigilance overlapped with mention of negative emotions that might in future be associated with cycling. Very scary events in particular were characterised by such descriptions (e.g. future 'paranoia' around trucks). While many events might be annoying but soon forgotten, some were described as being likely to damage future experiences of cycling, making people angry or fearful:

'I will be a lot more cautious cycling on roundabouts as it has affected my confidence levels. I feel vulnerable on the roads.'

'At the moment I lack confidence & feel nervous when vehicles come from behind. I'm fed up with drivers overtaking me towards oncoming traffic & providing me with insufficient room &/or nearly pushing the other vehicle off the road.'

4.3.2.3. Expecting nothing to change. Although cyclists answering this question had already said their cycling would be affected in future, one in seven then said that nothing would change:

'It happens all the time, I expect it.'

'I will likely encounter similar traffic on future commutes.'

Such comments express both the feeling that cycling is negatively impacted by incidents such as those reported in the survey, and a sensed powerlessness.

4.3.2.4. Primary position. For those who did cite a change in behaviour, the most commonly described change was to take 'primary position' (see DfT, 2012), riding to physically prevent unsafe overtaking.

'I shall [. . .] assert my place on the road. If I move over [i.e. pull into the kerb], I find that many drivers accelerate, increasing the risk further.'

'Should have cycled even more towards the centre of the road to try and stop car squeezing past where there is no room.'

However, many said blocking drivers was not always easy, and could be interpreted as discourtesy, potentially leading to more serious incidents:

'I'm going to ride much wider at that pinch point, and if it means holding up the traffic for a few seconds, and if I get shouted at or have stuff thrown at me (more than normal) I don't care.'

4.3.2.5. Hanging back. Taking primary position requires integration within traffic flow, using the space that a car would take. However, other responses involved staying back, slowing down, and/or keeping out of the way of motor vehicles:

'I will stay further back from vehicles in future, so that I have more time to get out of the way if they unexpectedly begin reversing towards me in the middle of the street.'

In some situations a cyclist would technically have right of way, but believed that this would not be respected. Hence, they would wait:

'I'll probably assume that buses won't respect my right of way here and hang back.'

4.3.2.6. Avoiding routes. A common response was to attempt to avoid areas or routes. However, some claimed that they had already tried this, or that choosing alternative routes was likely to involve substantial detours or other problems (e.g. personal safety after dark).

'I will avoid this road, take a longer route or cycle on the pavement.'

'I went that way because it was more direct, I should have known better.'

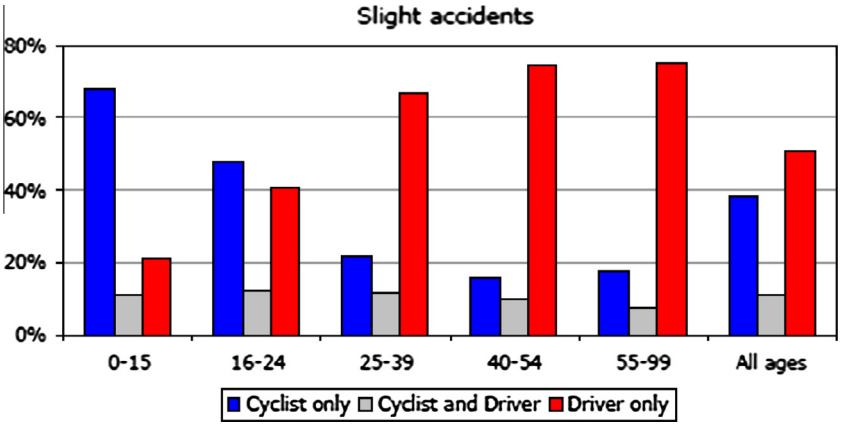

Fig. 2. Police attribution of responsibility for slight injuries involving cyclists, by age of cyclist. Reproduced from Knowles et al. (2009).

This last comment expresses a resigned assumption that direct routes for cycling will inevitably be unsafe. This idea was noted in another recent survey of cycle infrastructure preferences in which many respondents commented unprompted that they assumed good infrastructure would involve substantial diversion (Aldred et al., 2016).

4.3.2.7. Avoiding cycling. According to participants, around one in sixty 'very scary' incidents directly led them to consider stopping cycling or cycling less:

'It makes me nervous on this stretch of road and puts me off cycling and may make me drive instead in bad weather or when the days get shorter so that my return journey is in the dark.'

'I cycle 6000+ miles a year. I'm hardened, I've seen just all the idiocy I thought possible. But this crazed and deliberate bullying behaviour [being deliberately driven at] is just about the only thing that seriously makes me consider giving up.'

Data on avoiding cycling was also analysed at person-level[6] to ensure individuals were not over-represented. 26 different participants identified one or more incidents that they said had led them to consider cycling less or not at all. This represents 1.7% of all diarists and hence, assuming a regular commuting cyclist riding on 250 days per year, implies that the average commuter might experience 4–5 incidents annually which lead them to consider stopping cycling or cycling less.

4.4. Cyclist views on incident prevention

Cyclists were asked what they thought might have prevented an incident from happening. Most, they thought, could have been prevented, with only 2.7% (109) definitely not preventable. According to cyclists 19.1% could have been avoided by them doing something differently, 53.3% by a different road condition, layout or infrastructure, and 78.7% by another person involved behaving differently. Overall, cyclists said 83.2% of incidents could have been prevented by someone else and/or by the road environment being improved, with only 3.9% definitely not preventable by either.

Motorists would probably have different views on prevention, perhaps especially relating to behavioural contributors. To explore how biased or reliable cyclists' views might be on this, I compared them to Knowles et al.'s (2009) analysis of police views on contributory factors for cycling injuries. Looking only at incidents in the Near Miss Dataset involving a motor vehicle, cyclists said that in 18.9% of cases they could have avoided the incident, while in 87.1% of cases someone else (usually a driver) could have avoided the incident.

Thus overwhelmingly the picture is of greater driver responsibility, which one might expect given the cyclist's perspective. But what do the police think in relation to slight collisions, the most comparable type of Stats19 incident? Two key points from Knowles et al. (2009) are that attribution varies dramatically depending on (a) whether a victim was under or over 25, with younger cyclists judged responsible much more often, and (b) incident seriousness, with more serious incidents more likely than less serious incidents to be attributed to a cyclist's behaviour. Leaving (a) aside (our dataset included no children, and relatively few adults under 25), (b) may possibly be related to the fact that the most serious incidents, the recording officer is unlikely to hear the cyclist's perspective.

For slight injury incidents involving cyclists aged 25 and over, police overwhelmingly attributed contributory behaviour to drivers rather than cyclists (Knowles et al., 2009: 33). For example, for cyclists aged 40–54, around three-quarters of slight injuries were judged to have been caused by driver behaviour alone, while for around one-quarter, police identified contributory behaviour on the cyclist's part. For all age groups over 25 Knowles et al. (2009) found driver contributory factors identified in between two-thirds and three quarters of cases. So while the magnitudes are different, the overall picture is not (see Fig. 2).

[6] Because of low numbers, data was also checked to ensure that this related to individual participants as well as individual diary days (7 of 1525 individuals completed two diaries).

Table 4
Prevention by others.

Characteristic/behaviour	Count	Weighted percentage (% of content related to prevention by others)	Similar words
Waited	626	2.68	Wait, waited, waiting, waits
Looking	428	1.83	Look, looked, looking, looks
Passing	351	1.50	Pass, passed, passing
Stopped	189	0.81	Stop, stopped, stopping, stops
Space	182	0.78	Space, spaces
Slowed	157	0.67	Slow, slow, slowed, slowing, slows
Patient	126	0.54	Patient, patiently
Aware	122	0.52	Aware, awareness
Room	122	0.52	Room
Checked	107	0.46	Check, checked, checking

4.4.1. Cyclists preventing incidents

Only one in five incidents was described as potentially preventable by the cyclist, demonstrating a general feeling of lack of control over incidents. Even where cyclists said they might have prevented an incident, descriptions suggested that they were not confident of this. Many commented that behaviour attempting to prevent the incident might have led to a worse incident: for example, taking another route risking more serious conflicts. Other strategies suggested were illegal, such as using the footway or cycling through red lights. Some said the only way they could have avoided an incident was to dismount. There was often a sense of frustration at not being able to work out what, if anything, could have been done differently:

'I have been trying to work out if I had done anything wrong in that right turn. I have a good hand signal and made sure I was well in the centre of the lane, but the driver still pushed past. Maybe I didn't claim the lane enough and he thought he could just pass as usual? Maybe I should have been even more assertive? Or maybe I should have just got off and used the zebra crossing nearby!'

Knowles et al. (2009) found that for killed or seriously injured cyclists aged 25–39, the top ten identified contributory cyclist behaviour factors were failing to look properly, failing to judge someone else's path or speed, poor turn or manoeuvre, being careless/reckless/in a hurry, loss of control, entering the road from a pavement, wearing dark clothing at night, overshooting a junction, disobeying give way or stop markings, and not displaying lights at night or in poor visibility. Most were relatively uncommon; by far the most common contributory factor attributed to cyclists (1/3 or more cases where problematic cyclist behaviour by an adult was identified, well ahead of other behavioural causes) was failing to look properly. This to some extent maps with the focus in the near miss sample on increased vigilance and caution.

In other respects however there is discrepancy between cyclist- and police-identified preventive/contributory factors. Perhaps while cyclists reasonably accurately locate blame (or at least, their views are fairly congruent with police views) they are less good at identifying what they might have done differently. Conversely, most UK police officers have little first-hand experience of cycling, compared to driving, which might affect their ability to judge contributory factors. This broader context also shapes the Stats19 categories that direct police responses. These do not include preventing factors cited by cyclists here such as 'not taking primary position' or indeed law-breaking or dismounting.[7]

4.4.2. Others preventing incidents

Cyclists said almost four in five of all incidents (six in seven 'very scary' incidents) could have been prevented by another person. Suggestions often involved drivers being more patient, slowing down, or looking more carefully. The Table 4 illustrates characteristics and behaviours most commonly requested from drivers (and occasionally other cyclists, or pedestrians):

Combining the most popular codes, waiting/patience were mentioned 752 times, looking/awareness/checking 657 times, giving space/room 304 times, stopping 189 times, and slowing down 157 times. These broad factors can be compared to factors identified in the Stats19 data and here there are more similarities. The top ten driver behaviour factors where serious or slight injury to a cyclist resulted (Knowles et al., 2009) are failing to look properly, poor turn or manoeuvre, careless/reckless/in a hurry, failure to judge another person's path or speed, passing too close, negligent opening of a vehicle door, disobeying stop signs or give way marking, dazzling sun, stationary or parked vehicles, and aggressive driving.

While those categories are not all comparable to the ones used in the Near Miss Project, similarities are clear, and the top five Near Miss Categories appear in the top five Stats19 categories. Knowles et al (2009) further comment that research shows that 'motorists perceive there is a 'social norm' for motorists to pass cyclists even if they do not think it is safe to do so'. This is behaviour that cyclists in this study highlighted as a frequent problem. It causes injuries: in fatal cyclist col-

[7] Instead, the assumption embedded in these categories is that legally correct road user behaviour should in normal circumstances prevent injuries.

lisions, police cited 19% as involving a close pass as contributory behaviour, rising to 29% where a goods vehicle, bus or coach was involved (Knowles et al., 2009).

4.4.3. Changing cycling environments

Over half (52.8%) of incidents could have been prevented by a change in the cycling environment, according to participants. This data could not be directly compared with Knowles et al. (2009) due to limited information about infrastructural as opposed to behavioural factors. Debates continue about infrastructural prevention of cycling injury (International Transport Forum, 2014; Park et al., 2015); some authors increasingly highlight the role of separated infrastructure (e.g. Teschke et al., 2012; Talbot et al., 2014). Similarly in this dataset, the top change suggested was an increase and/or improvement in dedicated space for cycling (often described as cycle lanes, tracks, or paths), mentioned in relation to 826 (20.7%) incidents. The second most popular change was repairs to road or other infrastructure, incorporating maintenance and barrier removal, cited for 598 (15.0%) incidents.

Other less commonly suggested changes included junction redesign (268 comments), traffic calming (166), widening roads, including removing pinch points (145), removing or relocating car parking (142), enforcing existing regulations (62), and changes to pedestrian provision, such as more footway space (56). In many cases more than one change was suggested in combination or as alternatives. Despite the impressive rise of 20 mph limits within UK policy debate, there was little mention of this.

Comparing incidents where separated provision was cited to those where it was not, the former were significantly more annoying and scary. For 'very scary' incidents separation was cited in 26.5% of these compared to 19.8% of other incident types. One might compare these findings to Talbot et al.'s analysis (2014) of 53 London crashes involving cyclist deaths or life-threatening injuries, which concluded separation could have been a preventive factor in at least a third of cases.

For incidents involving, or caused by, larger vehicles, there was a consistent tendency for separation to be cited. Where the primary cause was a car, 25.0% (420) cited separation; comparable figures for incidents caused by buses and HGVs are 34.7% (60) and 31.2% (48). For incidents caused by pedestrians and by cyclists, the figures are 13.6% (60) and 10.6% (21). Where a bus or an HGV was *involved* (not just as the primary cause), separation was cited by 32.5% (63) and 32.5% (92) respectively, again significantly higher ($p < 0.05$) than for other incidents.

These figures highlight qualitatively different types of incident. More frightening incidents, involving motor vehicles (particularly larger motor vehicles), were associated with suggested separation from motor traffic. By contrast, repairs, maintenance and the removal of barriers were largely cited as responses to incidents not involving motor vehicles: 39.9% for these, vs. only 4.3% for incidents involving motor vehicles. By incident type there are also clear differences: passing incidents are strongly associated with separation (cited in 32.8% of cases, vs. 3.5% citing repairs), and blocking with repairs (35.2% of cases, vs. 14.0% citing separation).

Person-level analysis was conducted to ensure individual experiences count equally, as incident numbers varied. 38.6% of those experiencing any incidents suggested separation from motor traffic could have prevented at least one of these. As would be expected, this proportion grew as number of incidents increased. Further exploring person-level preferences, I built a binary logistic regression model (see Appendix A), including demographic factors. The outcome variable was whether a person suggested separation from motor traffic for one or more incidents. Unsurprisingly, this was associated with number of incidents; the other two significant variables being speed and gender. A slower cyclist was more likely to cite separation, while women were less likely to cite separation. As women rode on average more slowly than men, the two effects balanced each other and thus crosstabulations showed no statistically significant difference in citing separation by gender.

4.5. Safety in numbers and near misses

The paper provides data related to the 'safety in numbers' hypothesis, not previously investigated for non-injury incidents. The hypothesis seeks to explain the association between higher levels of cycling and lower injury rates, suggesting physical and/or societal pathways related to driver behaviour (Jacobsen et al., 2015). The first involves cyclists being safer on streets where there are physically more cyclists, perhaps due to greater visibility. However, Aldred and Crosweller (2015) found no evidence of 'near miss' safety in numbers by time of day. This is perhaps not surprising, because the peak for cycling is also the peak for motor vehicle use, and as the UK still has little separated cycling infrastructure peak time cyclists are generally sharing with high numbers of motors. However, it highlights that 'safety in numbers' related to on-street visibility may be offset by motor vehicle volume, which may affect cycling experience.

Analysis conducted for this paper investigated the 'cultural' dimension of safety in numbers. This hypothesis suggests motorists in higher-cycling areas are more likely to cycle themselves or to know cyclists, so have better understanding of cyclists' needs and/or less hostile attitudes towards them. The analysis used only participants living in England and Wales for which comparable Census 2001 and 2011 data was most easily available (89% of participants). Correlating near miss rates per mile against 2011 cycle to work rates, a weak positive correlation was found (0.073, $p < 0.05$); for increase (or decrease) in cycling between 2001 and 2011, a similar positive correlation was found (0.072, $p < 0.05$). Adding these variables to a

previously utilised regression model with logged incidents per mile as the dependent variable (see Aldred and Crosweller, 2015) resulted in neither being significant.

5. Discussion

5.1. Principal findings

5.1.1. Using near miss data to prevent injuries

Comparison of the data reported here with Knowles et al. (2009) has suggested that cyclist reporting of near miss incidents is not substantially different, in terms of responsibility, to police reporting of cyclist slight injury collisions. In addition, many driver behaviour factors reported are similar. This gives confidence (a) that self-report near miss data reasonably accurately reports events and (b) near miss incidents may provide 'early warning' of situations or behaviour that could lead to injury.

Thinking about injury prevention, some types of near miss are more important than others. For some incident types, such as dooring and hooking, injury risks are very high and studying near misses at particular locations could help injury prevention. Close passes are associated with injury collisions, and should be high priority for injury prevention and perceived safety due to their high frequency. By contrast, 'driving at' incidents should be addressed to improve perceived safety, but are unlikely to lead to injury. Blocking incidents are less important for injury prevention and perceived cyclist safety,[8] but are important for ensuring pleasant and uninterrupted journeys.

In using near miss data for injury prevention, consideration should be given to using subjective and/or objective data, depending on the circumstances. For close overtakes, unlike other types of near misses, there is a broader 'objective' literature some of which allows comparisons. Walker et al.'s (2014) recent study measured frequency of reported close passes as a proportion of all passes, finding 1–2% were extremely close (under 50 cm), based on 5690 passing observations for 67 cycle trips, each 16.25 miles (Walker et al., 2014). This equates to around 0.05–0.1 close passes per cycled mile, while our participants experienced on average around 0.05 close passes per cycled mile (Aldred and Crosweller, 2015). This suggests (a) close passes are a common experience for different types of UK rider and (b) subjectively recorded events correspond to potentially observable events.

5.1.2. Preventing near miss incidents

The vast majority of near misses were judged potentially preventable by changes to road user behaviour and/or the cycling environment. Behaviours that cyclists said might have prevented incidents are routinely promoted in campaigns[9]; however, it seems cyclists continue to encounter poor behaviour that if not always illegal may contravene the Highway Code. Phillips et al. (2011) found larger effects associated with safety campaigns combined with police enforcement, and involving roadside or face-to-face communication. This suggests publicity campaigns aimed at preventing cycling near misses could most effectively be used alongside targeting and enforcement of particularly problematic behaviour, often chargeable under existing offences (e.g. careless or dangerous driving). Such cases might include poor behaviour by commercial drivers. Legal or Highway Code changes (e.g. on side road priority) might help to reinforce a desired change in driver behaviour, although there is little evidence on the impact of such changes and we did not find much suggestion of this in our dataset.

However, the inter-relation of culture and infrastructure means that, for instance, a 'behavioural' problem does not necessarily need to be addressed only by 'behavioural' interventions. Shackel and Parkin (2014) have shown driver overtaking behaviour is influenced by road characteristics: changes to road widths might reduce or increase problem overtaking behaviour. Implementing this consistently through road design guidance and standards would be an example of an infrastructural response to a 'behavioural' problem.

Thus 'behavioural' and 'infrastructural' factors identified in this data are not in competition. The former relate to desired changes in behaviour, the latter to specific changes to road infrastructure – which might indeed act through resultant behaviour change, as where traffic calming was requested to encourage drivers to act more carefully, for example. In other cases, traffic calming was cited as causing near miss incidents, due to poor driver behaviour: rather than being vigilant at road narrowings, some drivers were reported as expecting to be 'winners' in resultant conflicts with cyclists (see also Gibbard et al., 2004).

Driver behaviour may also underline the perhaps surprising lack of comment on 20 mph speed limits, highlighted in Reid and Adams (2011) as potentially making a substantial contribution to cyclist safety. While achieving speeds of 20 mph or less may indeed help reduce injury risk, driver behavioural responses may make traffic calming or legal interventions problematic. More research is needed on relationships between behaviour, culture, and infrastructure, but it is important to highlight that widespread reports of poor driver behaviour do not imply only tackling this by education or enforcement, while conversely infrastructural changes may be threatened by unchallenged poor driver behaviour.

[8] Where pedestrians are involved they may be frightening and stressful for the pedestrian so perceived safety may still be an issue.
[9] E.g. http://www.tfl.gov.uk/campaign/share-the-road.

Good quality separated cycling infrastructure, along links and at junctions, stood out as the most popular infrastructural intervention to reduce near misses. Given the substantial impact of near misses on perceived safety and cycling experiences, this provides an additional argument for such provision. One might compare 'fear of cycling' in the UK with the lack of fear attached to walking, despite similar injury rates. Footways for walking have not removed risk, but do – I would argue – contribute to greater perceived safety of walking, important for walking uptake and experience.

Finally, it is worth pointing out that many respondents felt relatively powerless to prevent incidents themselves. Problematic driver behaviour and infrastructure identified by respondents contributed to this. For example, many respondents were aware of guidance to take 'primary position' to prevent dangerous overtaking:

> 'Trainees may be wary of cycling in the primary position [...] However, where appropriate, *it will actually offer them more protection* as they will be able to see more, be seen more easily by other road users and *most importantly it will prevent drivers from attempting to overtake them where the road is too narrow*.'
>
> [DfT, 2012, my emphasis]

However, participants suggested that this might swap a high risk of a close pass for a lower risk of a more extreme, perhaps deliberate incident. For a group already seen as vulnerable, taking up additional physical space can be challenging, even if objectively safer.

5.1.3. Experience-focused perspectives

The paper has demonstrated the usefulness of an analysis of quantitative and qualitative data about experienced cycling risk. The project uncovered everyday incidents whose impact is often hidden, but which – perhaps especially when experienced by newer cyclists – may contribute to the rate at which people stop cycling. This was illustrated by comments in which many participants reflected on how they, as long-time cyclists, had normalised such experiences. For example:

> 'All the incidents that I have mentioned are usual occurrences and something I have got used to. It was only by knowing I was doing this survey that I noticed the number.'

The problem sharing with motor vehicles – particularly large ones – poses for cyclists can be seen as one of experience as well as perception and/or injury risk. By contrast, while conflicts with pedestrians and other cyclists could be frustrating, they were generally less annoying and frightening. This is in line with a recent interview study by Lee et al. (2015), which found crashes involving motor vehicles had more negative emotional consequences than solo crashes, while near misses with motorists could have substantial emotional impact, despite lack of injury.

Why are near misses so frightening? One reason might be that – in low-cycling contexts – they reinforce a broader view of cyclists as unwelcome interlopers within car space (Daley and Rissel, 2011). Near misses then may represent not just a chance of injury, but an identity threat: having a position as a stigmatised road user (Aldred, 2013) created or reinforced. Our participants pointed to a heightened sense of vulnerability coming from apparently not being seen (despite, for example, using bright lights or wearing high-visibility clothing), linking this in some cases to a lack of recognition as being a legitimate road user:

> '[It] made me feel vulnerable and reminded me that a driver's failure to look causes a great risk. It also left me frustrated because I wasn't sure that the driver even noticed that he'd nearly caused a collision and because of this he won't have reason to change his behaviour in future.'

> '[I was] annoyed because the driver didn't indicate and didn't notice me as I had lights and an orange jacket on. Either that or they did notice me and just expected me to get out of their way.'

Part of what is involved in drivers 'seeing' cyclists is attention conspicuity – 'the distinction of an object based on the observer's interest and experience' (Tin Tin and Woodward, 2014: 1). Could negative attitudes towards cyclists (DfT, 2010; Christmas and Helman, 2011) lead to them being ignored, not 'seen' or otherwise treated without care? Some participants did interpret not being noticed or acknowledged as being part of an expectation that cyclists should defer to larger vehicles:

> 'I feel like if I had been a car they would have paid more attention/taken more care. I overtook them later in the traffic and when they passed me again I don't think they noticed me or cared about my safety at all – annoying and unnerving.'

We cannot be sure that negative attitudes towards cyclists found in the broader culture are, as suggested by some participants, feeding through into careless or dangerous behaviour towards cyclists on the roads. However this connection is plausible, and was made by participants. In this context, it is a concern that the project found no 'cultural' safety in numbers effect for non-injury incidents, in contrast to similar cross-sectional evidence about injury rates. One reason may be the subjective component of near miss reporting; perhaps those cycling in higher-cycling areas are on average more sensitive to near misses. Here, area-based cycling levels were inversely correlated with cyclist age (-0.163, $p < 0.05$); older cyclists, who tended to report slightly lower near miss rates, tended to live in lower-cycling areas. The implication would be that as cycling grows, any increases in objective safety may at least initially not be accompa-

nied by increases in perceived safety. If new cyclists are disproportionately discouraged from cycling by near misses, this may have contributed to the failure to diversify cycling uptake in places where cycling has risen in the UK (Aldred et al., 2015).

The strength and weakness of this research is its in-depth focus on the cyclist's perspective. Some incidents are likely to remain under-reported; particularly where there is no fear or annoyance caused to the cyclist, but s/he may have frightened or annoyed others. Thus we must look elsewhere to understand the impact that cyclists might have on pedestrians. More research could usefully be carried out to explore and compare how different road users experience near misses. Other research could focus on micro-geographies and route characteristics (using GPS methods), and could for example compare 'objective' and 'subjective' measurements of near misses for different cyclists.

6. Conclusions

The data discussed here suggests that many, perhaps most, near misses are preventable. Understanding their impacts and developing ways of preventing the most frightening experiences can therefore contribute towards reducing the currently high perceived risk of cycling. The more problematic near misses described here will need to be addressed by a range of interventions, infrastructural and behavioural. Hopefully, each can reinforce the other. High-quality infrastructure and appropriately designed enforcement and educational campaigns to reduce poor driving may all help address cycling stigma, contributing to any cultural 'safety in numbers' effect. By contrast, poor cycling provision or ill-thought out safety campaigns might reinforce perceptions of cyclists as a marginal minority (Aldred, 2012, 2013).

The sheer frequency of incidents that are problematic for cyclists, and their emotional impact, indicate a substantial problem for policy aims of promoting cycling. Many respondents were informed, experienced and confident, but, even so, felt there was no way that they could prevent the majority of incidents. Particularly frightening incidents, and those involving vehicles posing the largest hazards to cyclists, were seen as most likely to be prevented by separated infrastructure. Previous studies have shown a preference for this provision and recommended its greater use in low-cycling contexts (Pucher et al., 2011), sometimes specifically in relation to injury prevention (Park et al., 2015; Reynolds et al., 2009). However, this study is the first specifically to link preferences for separated provision with the view that this might have prevented experienced near misses.

Finally, the study limitations include (a) the use of a convenience sample; (b) the lack of a comparable study in a high cycling country, especially one with separated infrastructure, and (c) the lack of a similar study among drivers and pedestrians in the UK. Future research could help fill these gaps and develop our knowledge of this important area.

Acknowledgements

Thanks are due to participants, to the funders (Creative Exchange and Blaze.cc) and to collaborators including in particular Sian Crossweller, who assisted with coding quantitative data, and Katrina Jungnickel who assisted with some of the qualitative coding. I would like to thank the peer reviewers for their contribution to this manuscript.

Appendix A

Logistic regression

Case processing summary			
Unweighted cases[a]		N	Percent
Selected cases	Included in analysis	1265	82.6
	Missing cases	267	17.4
	Total	1532	100.0
Unselected cases		0	0.0
Total		1532	100.0

[a] If weight is in effect, see classification table for the total number of cases.

Dependent variable encoding	
Original value	Internal value
No	0
Yes	1

Block 0: Beginning block

Classification table[a,b]

	Observed		Predicted		
			Prevention by separation		Percentage correct
			No	Yes	
Step 0	Prevention by separation	No	772	0	100.0
		Yes	493	0	0.0
	Overall percentage				61.0

[a] Constant is included in the model.
[b] The cut value is 0.500.

Variables in the equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 0	Constant	−0.448	0.058	60.513	1	0.000	0.639

Variables not in the equation

			Score	df	Sig.
Step 0	Variables	IncidentsDer	61.591	1	0.000
		ANYVSCARY	10.148	1	0.001
		ANYVANNOY	15.742	1	0.000
		Age	33.810	1	0.000
		WEEKEND	12.194	1	0.000
		GenderDum	0.019	1	0.890
		ANYamPEAK	2.399	1	0.121
		SPEED	13.786	1	0.000
		WORK	16.747	1	0.000
		London	6.964	1	0.008
		Scotland	0.523	1	0.470
		IncPerMile	9.903	1	0.002
	Overall Statistics		130.003	12	0.000

Block 1: Method = Enter

Omnibus tests of model coefficients

		Chi-square	df	Sig.
Step 1	Step	136.071	12	0.000
	Block	136.071	12	0.000
	Model	136.071	12	0.000

Model summary

Step	−2 Log likelihood	Cox & snell R square	Nagelkerke R square
1	1555.548[a]	0.102	0.138

[a] Estimation terminated at iteration number 4 because parameter estimates changed by less than 0.001.

Classification table[a]

	Observed		Predicted		
			Prevention by separation		Percentage correct
			No	Yes	
Step 1	Prevention by separation	No	650	122	84.2
		Yes	314	179	36.3
	Overall percentage				65.5

[a] The cut value is 0.500.

Variables in the equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	IncidentsDer	0.225	0.036	38.563	1	0.000	1.252
	ANYVSCARY	0.202	0.147	1.900	1	0.168	1.224
	ANYVANNOY	0.192	0.138	1.954	1	0.162	1.212
	Age	−0.031	0.006	23.535	1	0.000	0.970
	WEEKEND	−0.518	0.285	3.295	1	0.069	0.596
	GenderDum	−0.385	0.145	7.093	1	0.008	0.680
	ANYamPEAK	−0.089	0.169	0.279	1	0.597	0.914
	SPEED	−0.084	0.020	18.071	1	0.000	0.920
	WORK	0.315	0.159	3.945	1	0.047	1.371
	London	0.075	0.138	0.299	1	0.584	1.078
	Scotland	0.228	0.221	1.059	1	0.303	1.256
	IncPerMile	−0.182	0.187	0.950	1	0.330	0.833
	Constant	0.767	0.425	3.255	1	0.071	2.152

[a] Variable(s) entered on step 1: IncidentsDer, ANYVSCARY, ANYVANNOY, Age, WEEKEND, GenderDum, ANYamPEAK, SPEED, WORK, London, Scotland, IncPerMile.

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