Journal of Transport & Health 9 (2018) 96–104

Contents lists available at ScienceDirect

Journal of Transport & Health

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

Inequalities in self-report road injury risk in Britain: A new analysis of National Travel Survey data, focusing on pedestrian injuries

Rachel Aldred

University of Westminster, Faculty of Architecture and the Built Environment, Marylebone Campus, 35 Marylebone Road, London NW1 5LS, United Kingdom

ABSTRACT

In 2007, Britain's (since 2013 England's) National Travel Survey started asking respondents about experiences of 'road accidents'. This paper conducts new injury analysis using NTS data from 2007-15. The resultant dataset contains 147,185 adult individuals (weighted), of whom 17,990 reported experiencing one or more 'road accidents' in the three years prior to the survey date. This dataset includes incidents involving other road users and those that did not, less likely in general to be included in police injury data, and not at all in the case of pedestrian falls. The paper firstly compares this self-report injury data with police data, including comparisons for different user groups such as pedestrians, cyclists, and motorists. Most studies of under-reporting focus on deaths and serious injuries, due to lack of other data on slight injuries. Self-report data enables a focus on that majority of injuries which are slight but may impact people's experiences of travel.

The paper then compares the frequency of different types of pedestrian injury incident and finds that collisions in which a cyclist injures a pedestrian remain in this dataset very infrequent compared either to falls or to pedestrian injuries involving motor vehicles. Finally, characteristics of pedestrians injured by motor vehicles and in falls are examined. A binary logistic regression analysis examines odds of being injured as a pedestrian either by a motor vehicle, or in a fall, controlling for self-report walking frequency. Disabled pedestrians, those living in low-income households, and in London are at higher risk of being injured by a motor vehicle, while older and disabled pedestrians and women are at higher risk of being injured in a fall. Implications for policy and research are discussed.

1. Introduction

Policy-makers in UK and elsewhere seek to increase walking and cycling; 'vulnerable' yet healthy modes (DfT, 2017). Walking, once the 'forgotten mode' (Joh et al. 2015), is increasingly seen as crucial to sustainable city planning.[1] However, pedestrians experience higher injury collision risks than motorists, plus a further, under-researched burden from falls (Schepers et al. 2017). Even less serious injuries to active travellers are of concern both in themselves, and because high rates of slight injury may contribute to fear of injury. For cycling, much research suggests that such fear deters take-up and encourages desistance (e.g. Aldred et al., 2017).

Britain's modal disparities in injury risk have widened during the post-war period as motorisation accelerated (Sonkin et al. 2006). For example, despite substantial decline in per-km fatality risk for car users since the 1950s (DfT, 2016), the risk for cyclists only slightly improved (House of Commons Library 2013). Other research suggests substantial demographic disparities in road injury risk.

E-mail address: r.aldred@westminster.ac.uk.

[1] See e.g. Transport for London's new 'Healthy Streets' approach: https://tfl.gov.uk/corporate/about-tfl/how-we-work/planning-for-the-future/healthy-streets.

https://doi.org/10.1016/j.jth.2018.03.006
Received 22 August 2017; Received in revised form 13 March 2018; Accepted 14 March 2018
Available online 30 April 2018

This includes social class gradients and differences by ethnicity and age in pedestrian injury risk (e.g. Steinbach et al. 2016, Laflamme and Diderichsen 2000). However, frequently research does not control by use of a mode but rather by population, making it impossible to say whether apparently elevated pedestrian risk for Group A stems from group members walking more than Group B, or from their experiencing worse walking conditions when they walk.

Some studies do control for mode use. Using Hospital Episode Statistics (HES) data, Mindell et al. (2012) found that for young men in England, per-hour injury risks are higher for driving than cycling. However, across the population, per-hr or per-km injury risk for cyclists remain higher than for motorists. Using Stats19, Rolison et al. (2012) found elderly (> 70 years) pedestrians are at particularly high fatality risk, while for drivers and passengers a U-shaped relationship held. Results of comparisons depend upon whether the denominator measures time, distance, or trips (Mindell et al. 2012), particularly when including pedestrians. Rolison et al.'s (2012) comparison of car users and pedestrians found comparable per-trip fatality risks, while per-km results would be different.

Frequently used administrative data has limitations for understanding variation in injury risk by mode and demography. In Britain, most research on road injury risk uses police injury data ('Stats19'), which includes injury location and mode, limited victim demographics (no data is collected on disability, for instance), and vehicles involved.[2] Although data on deaths is accurate (DfT, 2016), systematic under-reporting affects injury data, especially slight injuries. In the 1970s researchers estimated three times more slight injuries occurred than were recorded by police (Ahmed et al. 2017). Ward et al.'s work (2006) suggests under-reporting has since increased. A further concern is skewing of under-reporting by mode and/or demographic group,[3] although due to lack of comparator data (especially for slight injuries) it is hard to know. Police may concentrate on incidents that legally must be reported, hence neglecting incidents not involving motor vehicles, and Stats19 never covers pedestrian falls.[4] Hospital data can be used to analyse incidents absent or under-represented in Stats19, especially on-carriageway falls (although there is some uncertainty over coding accuracy). However by its nature, hospital data contains even fewer slight injuries than Stats19.

Until recently, police and hospitals were the sole source of Britain's road injury data, except coroner's reports (Mindell et al. 2012). However, since 2007 the National Travel Survey[5] (covering Britain until 2012, from 2013 only England) has asked about 'road accidents'. Like Stats19, NTS data covers incidents on a public highway. However, it excludes neither single-bicycle incidents nor pedestrian falls. The data allows a different angle on injuries based on the perspective of those involved rather than police or hospital staff. There will still be some under-reporting, related to ability to recall or admit to involvement, which may differ by incident type, just as we know that police and hospital data may have differential under-reporting (Ward et al 2006). While most police recorded injuries are likely to be present in self-report injury data (Boufous et al. 2010), pedestrian falls may be less likely to be recalled than road collisions.

In Britain walking – unlike cycling – is both widespread and demographically diverse. This means that the NTS data is particularly valuable for the comparison of self-reported experiences of pedestrian injury. One factor that can be included is disability, a category under-researched in injury analysis partly due to lack of data.[6] One of few studies, in USA, found '[a]fter controlling for potential confounding variables, children with disabilities were more than five times more likely to have been hit by a motor vehicle as a pedestrian or bicyclist than children without disabilities.' (Xiang et al. 2006). This paper enables exploration of such possible risk differentials in Britain and alongside better-established risk factors such as age and gender (Schepers et al. 2017).

Further, the data offers the opportunity to compare risk factors associated with pedestrian injuries sustained in collision with those associated with falls. Road safety literature has tended to focus on the former, largely due to the exclusion of falls from road safety datasets (Methorst et al. 2017). However, a review by Tournier et al. (2016) focuses specifically on older pedestrians given the high numbers of falls injuries among those aged over 65. They highlight the impacts of physical and mental changes that may heighten risk (e.g. mobility limitations meaning that people are unable to walk further to a safer crossing, or changes in the ability to perceive and respond to threats) as well as the need to change attitudes of other road users towards older and disabled pedestrians. Pedestrian falls may have substantial impacts on individuals, including on the continued ability to live independently (Tinetti and Williams 1995).

The research conducted here (i) examines risk by mode in self-report injury data, comparing it to that in police collision data; (ii) focusing on pedestrian injuries, examines involvement (or not) of other road users and (iii) compares odds[7] of being involved in pedestrian fall or pedestrian-motor vehicle injury collisions by demographic group, controlling for walking frequency.

Research questions are:

(i) What does self-report data tell us about frequency of, and mode split for road injuries in Britain, and how does this differ from Stats19 data?
(ii) What are the main causes of pedestrian self-report injuries, comparing motor vehicle injuries, falls/, and pedestrian-cyclist collisions?

[2] Police records have more detailed geographical information, e.g. victim postcodes.

[3] In addition, methods of coding injuries as serious or slight changed in 2016 in many areas of Britain.

[4] And in practice often for cyclist falls, although these unlike pedestrian falls can be recorded in Stats19.

[5] https://www.gov.uk/government/collections/national-travel-survey-statistics.

[6] HES does not include such information. Stats19 data does include reference to disability, but as a 'contributory factor' in incidents, based on an officer's (a) identification of a disabled person as involved in an incident and (b) belief that this disability 'contributed to' the incident in question. The data is therefore unlikely to well represent disabled people's involvement in incidents and hence their risk of being injured.

[7] While binary logistic regression provides odds ratios, due to the rarity of the events here these approximate relative risks.

(iii) Controlling for time spent walking, what demographic factors are associated with elevated pedestrian injury odds, and does this vary by cause of injury?

2. Methods

2.1. Data

The NTS is a rolling, cross-sectional survey, using a household sample and incorporating interviews with household members and a seven-day travel diary. The required data is held by UK Data Archive's Secure Data Service (SDS), hence the author became an accredited researcher. Data covers Britain for 2007-12, but England only for 2013–2015. All data are used here so as not to lose any incidents.

NTS respondents were asked about involvement in incidents ('road accidents[8]') on 'a public road, including pavements and cycle lanes […] even if no other party were involved' over the past 3 years and 1 year, and about numbers of injuries. NTS has no data on incident location or date, so cannot easily be matched (as opposed to compared) to Stats19 or HES, nor examined in geographical detail.

NTS participants who experienced an incident during the last three years were asked for more details, including any injury and treatment, police involvement, mode used and involvement of others by mode. For data on mode used by participants or others involved, pedestrians, cyclists, motorcycles, and cars are separately listed, but all other vehicles are combined.

2.2. Dataset preparation

Using SPSS, the following steps were taken to prepare the NTS dataset used here:

(i) Pre-2007 data was removed
(ii) Data on under-16s (not directly asked 'accident' questions) was removed
(iii) New variables were created, relating for instance to whether someone was injured in their last incident.
(iv) Selected variables (region, household income) from the household-level dataset were merged in, matching by household ID.
(v) Data on trip stages on foot, on cycle, in a car, on a motorbike, and by other means of road transport within the past week (grossing up short walks, only reported on one day) were aggregated within the stages-level dataset, and merged into the individual-level dataset, using individual-level ID.

Individual-level weighting (W3) was used throughout, apart from where travel diary data was used (where diary weights are used instead) and all reported results are weighted. The weighted dataset contains 147,185 individuals, although usually with some missing values. For analysis using household- or stage-level variables those not fully participating in the travel diary were excluded.

When using Stats19 data to compare past-year injury rates, data on injuries among people aged 16 + was selected related to 2007-15. Data from Scotland and Wales in 2013–2015 was removed, as were deaths. The comparison slightly under-represents NTS injuries, as a few participants reported more than one past-year incident, but information on key variables such as mode is only present for the last injury incident.[9] Data on population numbers was sourced from Nomis, via the Annual Population Survey. This produced the relevant population base, i.e. adults 16 + in Britain in 2007-12 and England in 2013-5, to calculate a population injury figure from NTS for comparison to Stats19.

2.3. Analysis

Analysis was conducted in SPSS Statistics and Microsoft Excel. Initially, descriptive statistics were used to compare frequency of road injuries by mode, alongside per-hour and per-mile self-report injury risk by mode. For these latter rates, total hours and miles travelled per mode were calculated using data from the NTS's seven-day trip diary as described in (v) above.

The results were compared with Stats19 data; including published per-km rate-based tables (DfT, 2016) and new analysis of Stats19 data sourced from data.gov.uk for frequency and modal split data. Descriptive analysis was carried out to compare causes of pedestrian injury, involving identifying different incident types based on the involvement of other road users (no other road users involved – i.e. falls, cycle-pedestrian collisions, and collisions involving motor vehicles).

Binary logistic regression models were built with outcomes (i) being injured (or not) as a pedestrian by a motor vehicle in the past three years and (ii) experiencing a pedestrian fall injury (or not) in the past three years. Factors included were: (i) walking frequency, (ii) gender, (iii) age, (iv) disability, (v) household income under £25,000 and (vi) resident or not in London. These were selected from existing literature (e.g. Steinbach 2016 and Schepers 2017). Given relatively small numbers of injured pedestrians, variables with little variation (e.g. ethnicity) were excluded, as were those with many categories (e.g. region).

[8] In this paper I refer to incidents or on occasion 'accidents' rather than accidents, to reflect the belief that many road injuries are preventable and hence 'accident' is not an appropriate descriptor for road injuries in professional discourse. (It is understandable that NTS used this language.) See Freund and Martin (1997).

[9] In several cases numbers were very high and hence it might be assumed the people in question were using different thresholds to other participants for reporting incidents.

The reason for using a general 'walking frequency' question to control for amount of walking is that while overall NTS offers good estimates of the amounts of travel done by the population or by sub-groups, when doing individual-level analysis, walking time and distance are skewed towards those reporting day-7 short walks. Grossing up leads to an assumption that the individuals in question are doing seven times more distance via short walks in a week than they reported on day 7. However, in practice it would likely be a higher number of other individuals doing additional walking.

Moreover, a high number of people do not report any walking in the past week in the trip diary (c.58%, compared to 38% who say they only walk once a year or never in the general walking frequency question). This is likely partly to be due to the differing nature of the questions (general walking frequency vs trip diary) but also due to the short walks issue. Given walking variability, and the potentially poor nature of the proxy given injuries may have taken place up to 3 years ago, it was decided to use the walking frequency question (with three categories), a question with very few missing values.

3. Results

The sections below report the findings in relation to the three research questions.

3.1. Frequency of incidents and injuries, and mode split

3.1.1. Incident Frequency

Firstly, 12.2% (17,990 of 146,936 valid responses) said they had been in a 'road accident' in the last 3 years, of whom 85% (15,214 people) experienced one incident. Respondents involved in an incident in the past three years said the police attended in 24.3% of cases (3,470/14,274). Of those involved in an incident, 5610 (/17,980 who answered this question) said they were injured during the last incident. Most NTS injuries are slight. Of 4,306 injured in their last incident (over the past 3 years) and responding to detailed questions, 3,242 (75.3%) received medical attention but only 175 had an in-patient hospital stay.

Past-year incident data provides the number injured within the last year[10]: 2,474 people (1.7%). Of these, 2,377 people reported one past-year injury, and 97 reported more than one past-year injury. Hence, 96% of those reporting one or more past-year injuries were reporting exactly one past-year injury. The relevant population (calculated as described above) sums to 427,875,045 person-years. Grossing up 2,589 past-year injuries equates to 7,526,368 self-report injuries for that population during this period, while Stats19 contains 1,448,997 injuries. This suggests five times more self-report injuries than are recorded by the police, roughly in line with a quarter of NTS incidents having involved the police being present.

3.1.2. Mode split

Table 1 shows involvement in incidents and injury by mode. Not all respondents answered the more detailed questions about their 'road accident'. Of the 14,277 who did provide more information about their most recent incident over the past three years, 84% said they were in a car; 5% cyclists, 5% other vehicle users, 4% pedestrians and 2% motorcyclists. Just considering the 4,311 people injured in their last incident who stated their mode, the picture changes. Now 69% were car users, 12% cyclists, 8% pedestrians, 6% motorcyclists and 5% other vehicle users. Cyclists are the single largest group of 'vulnerable' injured road users in both three-year and one-year datasets, followed by pedestrians. Almost all injuries self-reported in NTS are relatively minor. However, severity differs between groups. Cyclists were more likely than other types of road user ($p < 0.001$) to report an injury for which medical attention was not sought (for instance, involving cuts and bruises).

Using the past-year injury figures and the NTS data on past-week distance travelled, the risk per mile and per hour, by mode, was calculated. Table 2 shows the resulting injury risks in relation to miles travelled and hours' use. The distance and time estimates are obtained from NTS travel diaries, and accordingly in this analysis, unlike the others, only the travel diary sample (and related weights) are used (133,431 people, weighted, and 130,470 people, unweighted). The final two columns show equivalent figures reported by DfT from Stats19, and the ratio between them.

In this dataset, per million miles travelled, cycling has the highest risk, while per million hours' use, motorcycling is higher. For the hour-based metric, walking has the lowest injury risk, while for the mile-based metric, cars and other motor vehicles have the lowest injury risks. The comparison with reported Stats19 figures show that the NTS reports around three times more injuries per mile for both walking and motorcycling. For car use and especially for cycling, the differential is higher.

For all incidents within the past three years in which people were injured, and more detailed questions answered, 17.9% (769) were incidents in which no other vehicles or pedestrians were involved. Injured car users were relatively unlikely to report this kind of injury, while by contrast, cyclists, motorcyclists, and pedestrians all reported just over a third of injuries were single-bike incidents or falls. For incidents where others were involved, participants reported a total of 3,598 categories of road user involved in their incident, not counting themselves.[11] Only 2% (104) were cyclists or pedestrians, while 83% were cars, 13% other vehicles, and 1% motorcyclists.

[10] Three-yearly figures are only 2.4 times greater than the number of past-year reported injuries. Perhaps people cannot so accurately recall injuries 2–3 years ago (or perhaps the passage of time leads people to re-classify very minor injuries as not injuries at all).

[11] Participants were asked whether for instance one or more cars were involved in the incident, excluding them (if they were in a car). Hence we do not know the total number of road users involved, because in the case of a large pile-up for instance, there may have been multiple cars involved.

Table 1
Injuries and involvement by mode, and percent seeking medical attention, past 3 years.

	In incident (percent of all in incidents)	Injured (percent of mode users involved in an incident)	Sought medical attention (percent of mode users involved in an incident)
Car occupant	11,975 (83.9%)	2987 (24.9%)	2348 (19.6%)
Cyclist	717 (5.0%)	521 (72.7%)	284 (39.6%)
Motorcyclist	342 (2.4%)	243 (71.1%)	182 (53.2%)
Pedestrian	512 (3.6%)	326 (63.7%)	250 (48.8%)
Other type of vehicle	731 (5.1%)	234 (32.1%)	177 (24.2%)
Total stating a mode[a]	**14,277**	**4,311**	**3,241**

[a] Not all reporting incidents or injuries answered follow-up questions, including which mode they were using.

Table 2
per-hour and per-mile risks by mode, comparison with Stats19 (past-year injuries).

	Injuries (last yr[a])	Injuries/million hrs use	Injuries/million miles	Stats19 injuries/million miles, 2006-15[b]	Ratio NTS: Stats19
Cycle	292	346	41	6.0	6.8
Motorcycle	112	491	20	6.5	3.1
Walking	160	17	6.4	2.3	2.8
Car	1190	36	1.4	0.3	4.3
Other	83	76	1.3	-[c]	-[c]

[a] all past-year injuries; rates then calculated using the travel diary sample, i.e. injuries reported by those filling in the travel diary divided by total travel reported by those filling in the travel diary.
[b] calculated from table RAS53001, reported in injuries per billion passenger km.
[c] not calculated.

3.2. Factors associated with pedestrian injury

3.2.1. Falls, motor vehicle and cycle collisions

The paper now considers factors associated with pedestrian injury during the past three years. These were split into three groups: those not involving other road users (i.e. falls), those involving a cyclist or another pedestrian (but no motor vehicles), and those involving motor vehicles. Injured pedestrians are defined as those injured as a pedestrian in their last incident during the past three years. Using these criteria and individual-level weights, there were 182 pedestrians injured in collisions with motor vehicles, and 121 pedestrian injury falls. Of the remaining 23 injured pedestrians, fewer than 20 reported injuries involving a cycle collision[12] and fewer than 10 reported injuries only involving other pedestrians.[13]

Due to low numbers of collisions involving only cyclists or other pedestrians, these are not investigated further, as statistical power would be insufficient to draw conclusions about differences between groups. These data hence provide no evidence as to whether any groups of pedestrians face elevated risk of being injured in collision with a cyclist. By contrast, falls and motor vehicle injuries (with > 100 cases each) do have sufficient numbers to allow investigation of factors associated with self-report injury risk.

Before carrying out the regression models below, descriptive statistics were produced to explore variation in motor vehicle and falls injuries in relation to the various demographic factors, and how these varied. Age was the most dramatic contrast between the two major categories of pedestrian injury incident, shown in Fig. 1. While there is no immediately clear pattern in relation to motor vehicle injuries per person, there is a substantial increase in falls risk per person at older ages.

3.2.2. Demographic disparities

This section covers demographic factors predicting pedestrian injuries, separating motor vehicle collisions from falls, as risk profiles may differ (Schepers et al. 2017). Regression analysis allows the impact of different demographic factors to be separated out, while separate binary logistic regression models were built for each individual factor to provide unadjusted odds ratios for comparison. The models include a measure of walking, based on reported usual walking frequency from the NTS interviews, allowing almost all participants to be included in analysis.[14] Some incidents may have led respondents to walk less, meaning that higher injury odds for one group may also reflect that group being disproportionately put off walking by an injury. However, across the sample and for sub-groups, injury status was associated with higher self-report past-week walking.

[12] Similar numbers of cyclists reported injury in a collision involving a pedestrian, but not motor vehicles.
[13] Due to disclosure control rules exact numbers not given.
[14] By contrast, using the past-week travel diary data would, as reported earlier, have excluded over half of all participants, due to (i) lack of participation in the diary and (ii) people reporting no past-week walking.

Table 3
Factors associated with higher odds of pedestrian-motor vehicle collision injury,[15,16].

	Adjusted				Unadjusted			
	p-value	Odds ratio	95% C.I.		p-value	Odds ratio	95% C.I.	
			Lower	Upper			Lower	Upper
Household income under £25,000	< .01	2.36	1.71	3.26	< .01	2.77	2.04	3.76
Male	.42	.88	.66	1.19	.13	.80	.60	1.07
Disabled	< .01	4.79	3.37	6.80	< .01	3.37	2.50	4.52
Age	< .01	.98	.97	.99	.09	.99	.99	1.00
London resident	< .01	1.91	1.34	2.71	< .01	1.85	1.31	2.62
Walking frequency (compared to rarely or never)	.13							
Walks 3+ times a week	.14	1.34	.91	1.97	.45	.87	.61	1.25
Walks 1–2 times a week	.93	.98	.61	1.57	.05	.63	.41	.99
Walks once a year or more, but less than once a week	.41	.79	.46	1.38	.01	.48	.28	.81
Constant	< .01	.00						

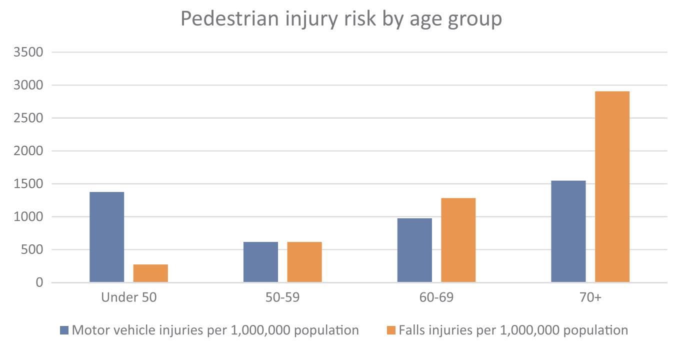

Fig. 1. pedestrian injury risk by age (N = 147,185).

3.3. Factors associated with pedestrian-motor vehicle injuries

Table 3 reports the results of a binary logistic regression model for motor vehicle injuries (177/181 injured people included, and 142,090 uninjured people included, incorporating weighting. In total, 140,186 unweighted participants are included).

The following are statistically significant ($p < 0.05$) in the maximally adjusted model:

- Living in a household earning below £25,000 was associated with more than double the odds of injury
- Living in London was associated with an almost doubling of injury odds
- Injury odds for disabled people were over four times higher than for non-disabled people
- Injury odds tended to reduce with age.

While the last point is a counter-intuitive finding, because of the much higher risk associated with disability, and the association of disability with age, in practice people in the oldest age group are at higher risk of motor vehicle injury than are people aged 50-69 (see Fig. 1). This paper is unusual in separating the impacts of age from those associated with disability.

3.4. Factors associated with pedestrian falls injuries

Table 4 reports the results of a binary logistic regression model for pedestrian falls injuries. 117/121 injured people are included, and 142,150 uninjured people are included, incorporating weighting. In total, 140,186 unweighted participants are included.

The model shows being female, disability, age, and higher reported walking frequency are associated with elevated risk. Specifically:

- Being female is associated with a doubling of injury odds

[15] Factors significant in the adjusted model are *bold and underlined.*

[16] Co-variates included are: (i) household income, as a binary variable (earning under £25,000, or not), (ii) gender (male/female), (iii) disabled (defined as reporting any disability, mobility or other), (iv) age in years, (v) resident in London or not, and (vi) self-reported walking frequency, for which there are four categories.

Table 4
Factors associated with higher risk of pedestrian falls injuries,[17,18].

	Adjusted				Unadjusted			
	p-value	Odds ratio	95% C.I.		p-value	Odds ratio	95% C.I.	
			Lower	Upper			Lower	Upper
Household income under £25,000	0.09	1.43	0.95	2.17	< .01	3.06	2.10	4.48
Male	< .01	0.43	0.28	0.65	< .01	0.40	0.27	0.59
Disabled	< .01	2.01	1.31	3.08	< .01	3.54	2.47	5.07
Age	< .01	1.05	1.04	1.07	< .01	1.06	1.05	1.07
London resident	0.71	1.11	0.64	1.92	0.61	0.87	0.50	1.49
Walking frequency (compared to rarely or never)	< .01				0.19			
Walks 3+ times a week	< .01	2.73	1.63	4.59	1.00	1.00	0.63	1.59
Walks 1–2 times a week	< .01	2.47	1.40	4.35	0.96	0.99	0.58	1.68
Walks once a year or more, but less than once a week	0.45	1.33	0.64	2.77	0.05	0.49	0.24	1.00
Constant	< .01	0.00						

- Being disabled is associated with a doubling of injury odds
- Age is associated with an increase in injury odds
- Greater reported walking frequency is associated with an increase in injury odds

4. Discussion

4.1. Summary of findings

The findings demonstrate firstly that self-report injuries are around five times more numerous than those recorded in police collision data. For cyclists, the level of apparent under-reporting is higher, with almost seven times as many incidents reported in the NTS data as are recorded in Stats19 (double the rate for motorcyclists or pedestrians). However, these incidents contained a relatively high proportion of injuries where medical attention was not sought. The level of apparent under-reporting for cyclists, while high, is consistent with other studies comparing self-report to police injury data (Winters and Branion-Calles 2017).

The data confirm that for pedestrians, injuries sustained in collision with a motor vehicle, or in falls, are both substantially more frequent than injuries sustained in collision with a cyclist or with another pedestrian. Because of the low frequency of cycle-pedestrian collisions, it is not possible to test whether any sub-groups of pedestrians are at particularly high risk of being injured in this way. Conversely, for the other types of injury (motor vehicle collisions, and falls) this is possible.

Statistical testing confirms that motor vehicle collisions and falls are distinctive types of event, with distinct victim profiles. One commonality is that disabled people seem to have particularly high risks of both events, although the relative risk is highest for motor vehicle collisions. There are however differences in other respects. Women have particularly high odds of having a fall-related injury, while for motor vehicle collisions, living in London or in a low-income household are associated with elevated injury odds. Finally, age has different effects on injury odds in the two different cases – associated with higher risk of a fall injury, but lower risk of a motor vehicle collision injury, when controlling for disability.

4.2. Strengths and limitations

The NTS data is an effectively new[19] dataset providing information on self-report injuries, based on a random household survey. It provides data on injuries affecting all modes, providing the opportunity here to focus on pedestrian injuries. The dataset cannot, however, be linked to any reporting datasets, and so cannot be verified in terms of police or hospital records. Indeed, most NTS incidents would not be present in either Stats19 or HES, being relatively minor injuries often not involving the police or hospital attention. Hence, we cannot simply see these data as representing the 'true' extent of injury. It is more complex than that, with bias and differences in reporting affecting self-report data, as well as police or hospital data.

For pedestrian falls, the NTS data is particularly unlikely to represent the 'true' picture. In this data, pedestrians report 50% more motor vehicle-related injuries than falls. However, a recent paper (Methorst et al. 2017) suggests that in Switzerland, Denmark, and Austria, 4–9 times as many pedestrians are injured in falls as in pedestrian-vehicle collisions. Given this, while NTS does ask people to report pedestrian falls, it seems likely that some people still do not see a fall as a 'road accident' as they would a collision, and hence do not report these. Additionally, there are reasons to believe that those most vulnerable to falls will not be covered in NTS. Falls

[17] Factors significant in the adjusted model are ***bold and underlined***.
[18] Co-variates included are: (i) household income, as a binary variable (earning under £25,000, or not), (ii) gender (male/female), (iii) disabled (defined as reporting any disability, mobility or other), (iv) age in years, (v) resident in London or not, and (vi) self-reported walking frequency, for which there are four categories.
[19] New in the sense that there is now enough data to carry out analysis.

injuries increase sharply for the 'older old' age groups (Schepers et al. 2017). Some will live in residential care homes or 'sheltered accommodation', ineligible for inclusion in the NTS household sample. Others may have moved to such a facility following a pedestrian fall within the past three years (falls being associated with an increased likelihood of such a move: Tinetti and Williams 1995), removing them from the sampling frame by the time of surveying.

Another disparity in relation to published evidence relates to cyclists. As confirmed by DfT (2016), the NTS data suggests that cyclists have substantially elevated injury risks compared to other road users. One factor here is likely to relate to injury severity, with 45% of cyclist injuries (compared to 25% for other road user groups) not involving the cyclist seeking medical attention. Perhaps this is unsurprising, given that in the UK cycling is skewed towards younger, fit, non-disabled adult males (Aldred et al 2016). This group may both be relatively robust following a collision or fall, and less willing to seek medical attention following a slight injury than others. However, the presence of such injuries in the NTS dataset does suggest that such injuries matter to those experiencing them, sufficient to be remembered and reported as a 'road accident' when asked.

In sum, this data is limited in being shaped by the survey designers' definitions of injury and 'road accident', like any other data source, and is likely to have been shaped by individual participants' understanding of that definition. Further, it is limited by the likely exclusion from the dataset of some of those from the group most at risk of pedestrian falls injuries (women in the oldest age groups). However, in reporting on self-report injury rates, it provides a window into experienced slight injuries for all modes, particularly in relation here to pedestrians.

4.3. Meaning of the Study: possible mechanisms and implications for policy

Risk factors here largely relate to slight injury, not to the more commonly analysed deaths and serious injuries. Their direct health burden is relatively small. However, these injuries may have important, less direct impacts. Like near misses (Aldred 2016) they may frighten people. Further, inequities in pedestrian injury risk are a social justice issue, especially as many groups at greater risk have fewer alternative options. Pedestrians in lower-income households have elevated risk of injury by motor vehicle, as do Londoners and especially disabled people. For falls, women and older pedestrians are at higher risk, as also found in the review by Schepers et al. (2017).

The findings in relation to cycling injuries may help explain the widespread perception that cycling in Britain is dangerous. Unlike Stats19, the NTS data suggests slight injuries to people cycling are, per user, more common than those to people walking (with most caused by motor vehicles). This alongside the much higher rates of walking than cycling may contribute to the perceived risk gap and contribute to reluctance to take up cycling, particularly among groups more sensitive to risk and where cycling involves mixing with fast and/or heavy motor traffic. By contrast while pedestrian falls are likely to be substantially more common than found here, these are concentrated among older age groups and hence may not have a similar impact in putting people of all ages off walking.

The data further provide insight into the interpretation of traffic safety concerns. Disabled people's groups frequently oppose 'shared space' designs, for instance. This is often treated as a 'comfort' issue, with planners highlighting the relatively good injury record of shared space environments. However, the data suggests that disabled pedestrians' concerns are not solely about perception,[20] but are based on experience of elevated risk of being injured by motor vehicles. By contrast, the fear of cyclists often expressed by pedestrians in Britain may be more a perception issue. The risk of being injured by a cyclist is low (and these data suggest that where there is a pedestrian-cyclist collision, injury risks for both may be similar) and there is no evidence here that cyclists pose greater risks to vulnerable pedestrians.

While around a third of the pedestrian and cyclist injuries on public roads reported here involve no one else, these injuries may be preventable. Countries with high levels of both cycling and cycling safety, such as the Netherlands, attempt to design routes that minimise such injuries (Schepers et al. 2015). For instance, older cyclists may be less able to manoeuvre around obstacles, hence reducing such infrastructure can help cut their (relatively high) injury risk. Similar approaches can be followed to reducing pedestrian falls. Given an ageing population, there is a need to address falls among older pedestrians, while maintaining active mobility, but this is under-researched (Schepers et al. 2017).

4.4. Unanswered questions and future research

Much additional useful work could be done using this and other data. For instance, it would be interesting to explore how injuries by mode have changed over the period, especially given an upward recent trend for cyclist KSIs in Stats19, alongside declines in pedestrian and motorist KSIs (DfT, 2016). It would be useful to explore, perhaps through qualitative work, the pathways through which some groups' injuries seem under-represented in official statistics, reasons for the higher risk experienced by disabled people and other groups, and the longer-term impacts of slight injury and fear of injury. Finally risks experienced by the oldest age groups could be addressed through targeted research on elderly populations.

References

Aldred, R., 2016. Cycling near misses: their frequency, impact, and prevention. Transp. Res. Part A: Policy Pract. 90, 69–83.

[20] As we do not record and study falls injuries as part of administrative road safety data, we do not know whether 'shared space' environments are associated with higher risks of falling for vulnerable pedestrians.

Aldred, R., Woodcock, J., Goodman, A., 2016. Does more cycling mean more diversity in cycling. Transport reviews 36 (1), 28–44.
Aldred, R., Elliott, B., Woodcock, J., Goodman, A., 2017. Cycling provision separated from motor traffic: a systematic review exploring whether stated preferences vary by gender and age. Transp. Rev. 37 (1), 29–55.
Ahmed, A., Sadullah, A.F.M., Yahya, A.S., 2017. Errors in accident data, its types, causes and methods of rectification-analysis of the literature. Accid. Anal. Prev. 1405(17), 30630–30638. 〈http://www.sciencedirect.com/science/article/pii/S0001457517302531〉.
Boufous, S., Ivers, R., Senserrick, R., Stevenson, M., Norton, R., Williamson, A., 2010. Accuracy of self-report of on-road crashes and traffic offences in a cohort of young drivers: the DRIVE study. Inj. Prev. 16 (4), 275–277.
Department for Transport, 2016. Reported road casualties Great Britain, annual report: 2015, available at 〈https://www.gov.uk/government/statistics/reported-road-casualties-great-britain-annual-report-2015〉.
Department for Transport, 2017. Policy Paper: Cycling and Walking Investment Strategy, available at 〈https://www.gov.uk/government/publications/cycling-and-walking-investment-strategy〉.
Freund, P., Martin, G.T., 1997. Speaking about accidents: the ideology of auto safety. Health: Interdiscip. J. Social. Study Health, Illn. Med. 167–182.
House of Commons Library, 2013. Road cycling: statistics, Standard Note: SN/SG/06224, available at 〈http://researchbriefings.parliament.uk/ResearchBriefing/Summary/SN06224〉.
Joh, K., Chakrabarti, S., Boarnet, M.G., Woo, A., 2015. The Walking Renaissance: a Longitudinal Analysis of Walking Travel in the Greater Los Angeles Area, USA. Sustainability 7 (7), 8985–9011.
Laflamme, L., Diderichsen, F., 2000. Social differences in traffic injury risks in childhood and youth—a literature review and a research agenda. Inj. Prev. 6, 293–298.
Methorst, R., Schepers, P., Christie, N., Dijst, M., Risser, R., Sauter, D., van Wee, B., 2017. 'Pedestrian falls' as necessary addition to the current definition of traffic crashes for improved public health policies. J. Transp. Health 6, 10–12.
Mindell, J., Leslie, D., Wardlaw, M., 2012. Exposure-Based, 'Like-for-Like' Assessment of Road Safety by Travel Mode Using Routine Health Data. PLOS One. 〈http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0050606〉.
Rolison, J.J., Hewson, P.J., Hellier, E., Husband, P., 2012. Risk of fatal injury among older adult drivers, passengers, and pedestrians. J. Am. Geriatr. Soc. 60, 1504–1508.
Schepers, P., Agerholm, N., Amoros, E., Benington, R., Bjørnskau, T., Dhondt, D., de Geus, B., Hagemeister, C., Loo, B.P.Y., Niska, A., 2015. An international review of the frequency of single-bicycle crashes (SBCs) and their relation to bicycle modal share. Inj. Prev. 21, e138–e143.
Schepers, P., den Brinker, B., Methorst, R., Helbich, M., 2017. Pedestrian Falls: a review of the literature and future research directions. J. Saf. Res. 62, 227–234.
Sonkin, B., Edwards, P., Roberts, I., Green, J., 2006. Walking, cycling and transport safety: an analysis of child road deaths. J. R. Soc. Med. 99, 402–504.
Steinbach, R., Green, J., Kenward, M.G., Edwards, P., 2016. Is ethnic density associated with risk of child pedestrian injury? A comparison of inter-census changes in ethnic populations and injury rates. Ethn. Health 21 (1), 1–19.
Tinetti, M.E., Williams, C.S., 1995. Falls, injuries due to falls, and the risk of admission to a nursing home. New Engl. J. Med. 337 (18), 1279–1284.
Tournier, I., Dommes, A., Cavallo, V., 2016. Review of safety and mobility issues among older pedestrians. Accid. Anal. Prev. 91, 24–35.
Winters, M., Branion-Calles, M., 2017. Cycling safety: quantifying the under reporting of cycling incidents in Vancouver, British Columbia. J. Transp. Health 7A, 48–53.
Ward H., Lyons R., Thoreau R., Under-reporting of Road Casualties – Phase 1, Road Safety Research Report No. 69, 2006, Department for Transport; London.
Xiang, H., Zhu, M., Sinclair, S.A., Stallones, L., Wilkins, J.R., Smith, G.A., 2006. Risk of vehicle–pedestrian and vehicle–bicyclist collisions among children with disabilities. Accid. Anal. Prev. 38 (6), 1064–1070.