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Cycling-related trauma admissions to the major trauma centre in the cycling capital of the United Kingdom

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ABSTRACT

Purpose: This study aims to characterise cycling related injuries presenting to a major trauma centre located within a region with the highest rates of cycling in the UK.
Methods: A retrospective analysis of cycling related trauma admissions occurring between January 2012 and June 2020 was performed. Our institution's electronic patient record system was used to collect relevant data for analysis including age, gender, mechanism of injury, Glasgow coma scale (GCS) on arrival, incident date and time, injured body regions, 30-day mortality, helmet use and intubation rate. Comparison was made between groups of patients based on mechanism of injury.
Results: A total of 605 cycling related trauma cases were identified, with 52 being excluded due to incomplete data. The most common mechanism was 'fall from cycle' (53.5%). The 'cyclist v vehicle' group was associated with a significantly higher Injury Severity score (ISS), lower GCS and higher intubation rate. Helmet wearers were significantly older than non-wearers and helmet use was associated with a significantly reduced risk of head injury, lower ISS and intubation rate and a higher GCS.
Discussion: With a likely increase in future cycling uptake, it is crucial that effective interventions are implemented to improve the safety of cyclists. The findings of this study may be used to guide any such intervention. A multi-faceted strategy involving driver and cyclist education, effective road infrastructure changes and helmet promotion campaigns specifically targeting the younger generation could be employed.

Introduction

The popularity of cycling in the United Kingdom (UK) is increasing, with the total number of miles cycled in the country increasing by 32% in the 20-year period between 1998 and 2018 [1]. During 2017-2018, 6.1% of the population cycled at least once a week and cycling accounted for 1.7% of all trips made [1]. However, in the same year, according to police recorded injury statistics, 5.5% of all road fatalities in Britain were cyclists, with 17,550 total injuries and 3,806 killed or seriously injured [2]. Cyclists accounted for 8.1% (17,437) of all road accidents in the United Kingdom, during 2019 [3]. When taking into account the number of miles travelled, cyclists showed an accident rate of 5,051 accidents per billion miles travelled [3]. This rate is far higher than equivalent rates for other road users including cars vans and heavy good vehicles, which show rates of 567, 227 and 250 accidents per billion miles travelled respectively [3]. Only motorcyclists, with an accident rate of 5,840 collisions per billion miles show a higher accident risk than cyclists [3].

There may be a number of potential reasons as to why cyclists appear to be particularly vulnerable road users. Fruhen et al found an association between drivers' positive attitudes towards automobiles and negative attitude towards cyclists [4]. These negative attitudes were also shown to be linked to aggressive behaviours [4]. This suggests that the importance and social value car drivers assign to cars and other automobiles may influence aggressive and dangerous driving behaviour towards cyclists [4]. The study of Meuleners et al also suggests that lack of appropriate road

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infrastructure, such as traffic signals and separation of cyclists from motor vehicles may also contribute towards a high cycling accident rate [5]. Furthermore, Useche et al finds that cyclists' risky behaviour may be influenced by cycling intensity, knowledge of traffic rules and risk perception [6]. Risky behaviour was shown to be more prevalent in younger cyclists and associated with traffic collisions [6].

The use of cycles as a means of transport is only likely to increase in the coming years, with the UK government recently embarking on a £2 billion campaign to promote cycling as a means of public transport, by the introduction of protected cycle-only corridors, safer junctions, distribution of cycle repair vouchers and a cycle to work scheme [7]. These schemes are to be put in place with the aims of, cutting carbon emissions, tackling high rates of national obesity and, more recently, virus transmission on public transport in light of the COVID-19 pandemic [7]. However, one major barrier to these plans lies in the perceived safety of cycling. The 2020 National Travel Attitudes Study found that 66% of adults agreed with the statement 'It is too dangerous for me to cycle on the roads' [8]. Therefore, it is crucial that with the likely increase in cycling uptake over the coming years, measures are also put in place to improve cycling safety and to make cyclists feel more comfortable on the country's roads.

Current literature characterising injuries to cyclists in the UK is sparse. This study aims to fill this gap in the literature by providing an analysis of cycling injuries from the unique perspective of the Major Trauma Centre located in Cambridge - the region with the highest rates of cycling in the UK [9]. In doing so, we aim to identify factors associated with both injury occurrence and severity, which may form the basis of future interventions aimed at increasing cycling safety.

Material and methods

No ethical approval was required for this study as all data was collected during routine patient care. This is a retrospective study of cycling-related injuries presenting to our Major Trauma Centre in the 8.5-year period between January 2012 and June 2020. The major trauma centre is the central hub in a regional trauma, hub and spoke, network established in 2012, made up of 12 trauma units serving a total population of over 6 million. Patients were identified using Trauma Audit and Research Network database (TARN), which allowed us to access details of all cycling-related injuries meeting all three of the TARN inclusion criteria: 1) Trauma patients irrespective of age; 2) Patients who have a hospital stay of more than three nights, who are admitted to critical care or who die during hospital stay; 3) Those whose isolated injuries fall into several categories, detailed in the appendix. TARN uses the abbreviated injury score (AIS) – a severity scoring system which classifies each injury in each body region on a six-point ordinal scale from 1 (minor injury) to 6 ('incompatible with life') [10,11]. Those patients with multiple injuries are scored by summation of the squares of the three highest AIS injuries in three body regions. This yields the injury severity score (ISS) – a measure allowing the assessment and comparison of injury severity [10,11]. All coding is performed centrally by a TARN coder.

Using an electronic patient record system, further relevant information pertaining to the retrieved injuries was recorded. Data collected included: patient demographics (age, sex, BMI), mechanism of injury and involvement of other road users, Glasgow Coma Scale on admission, intubation at the scene, incident date and time, helmet use, most severely injured body region according to AIS, number of injuries to various body regions and 30-day mortality. Incident occurrence during day- or night-time was calculated according to historical sunset and sunrise data for each individual accident date. Accidents were also grouped into seasons using The Meteorological Office UK meteorological season definitions (spring: March, April, May – summer: June, July, August – autumn: September, October, November – winter: December, January, February).

Statistical analysis

Patients were grouped according to one of three injury mechanisms: Cyclist v Vehicle (car, lorry, van, tractor), Cyclist v Cyclist and Fall from cycle (involving no other road users). These three groups were then compared using the variables described above. Statistical analysis was performed using IBM SPSS statistics 25. Use of the Kolmogorov-Smirnov test showed that all continuous dependant variables displayed a non-normal distribution. It was therefore decided to use the non-parametric Kruskal-Wallis test to compare continuous variables between the three groups. When this test identified a difference between these groups, the Mann-Whitney test with Bonferroni correction was used to perform pairwise group comparisons. When continuous dependant variables were compared between two groups only (e.g. helmet wearers v non wearers), a Mann-Whitney test was performed. The chi squared test was used to compare categorical data values. Statistical significance was defined as a P-value of less than 0.05

Results

From January 2012 to June 2020 inclusive, there were 605 cycling-related trauma cases admitted to the regional major trauma centre, recorded by the TARN database. Of these, 52 were excluded because the injury mechanism was not clear.

Mechanism of injury

The 553 remaining trauma cases were split into three groups: 'Cyclist v Cyclist' (Group 1) (n = 19, 3.4%); 'Cyclist v Vehicle' (Group 2) (n = 238, 43.0%); and 'Fall from cycle' (Group 3) (n = 296, 53.5%) (Table 1).

Patient demographics and incident timing

During the study period, the most common cycling-related injury mechanism was 'Fall from. Cycle', followed by 'Cyclist v Vehicle' and 'Cyclist v Cyclist' (Table 1). Patient demographics and incident timing overall and by injury type are shown in Table 1. The overall median age of patients was 47 years (range 3.6 – 89.8 years) (Table 1), with no significant difference between the three groups. All groups contained more male patients than female patients (Table 1)

Where documented, most accidents occurred in the 'day-time' (76.6 %, n = 302/394). In each group, more accidents occurred in summer than in any other season, and fewest in winter.

Annual incidence

Whilst the number of accidents meeting TARN criteria, admitted to our centre showed a generally increasing incidence across our study time period, the total number of police reported cycling-related casualties across Great Britain showed a downwards trend, during the same time period (Fig. 1). This trend is mirrored on a local scale, with the incidence of police reported cycling injuries in the Cambridgeshire region also showing a decreasing trend across the study period. All police reported figures are derived from the national report on road casualties [3]. The total number of cycling casualties admitted to our centre figure includes the 52 patients removed from further analysis due to a lack of data such as injury mechanism. Excluding these patients from annual incidence analysis would have artificially decreased the number of accidents in the

Table 1
Baseline patient and incident characteristics by injury type.

		Cyclist v Cyclist (n = 19) Group 1	Cyclist v Vehicle (n = 238) Group 2	Fall from cycle (n = 296) Group 3	Total (n = 553)
	Median age (years)	49.9 (7.2 – 72.2)	45.9 (6.4 – 90)	49.0 (3.6 – 88.8)	46.9 (3.6 – 89.8)
	Male:Female	13: 6 (68%:32%)	188: 50 (79%:21%)	239: 57(81%:19%)	440:113 (79.6%:20.4%)
	Day:Night	6:4 (60%:40%)	136:49 (26.5%:73.5%)	160: 39 (19.6%:80.4%)	302: 92 (76.6%:23.4%)
Season (%)	**Spring**	26.3% (n = 5)	25.6% (n = 61)	26.0% (n = 77)	25.9% (n = 143)
	Summer	47.4% (n = 9)	31.5% (n = 75)	33.8(n = 100)	33.3% (n = 184)
	Autumn	26.3% (n = 5)	27.3% (n = 65)	25.0% (n = 74)	26.0% (n = 144)
	Winter	0.0% (n = 0)	15.5% (n = 37)	15.2% (n = 45)	14.8% (n = 82)

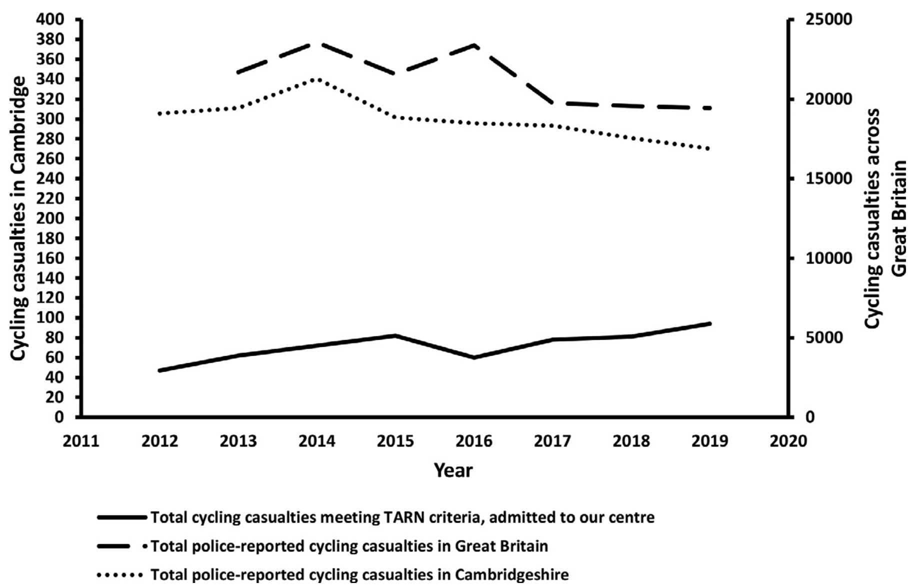

Fig. 1. Annual incidence of TARN database cycling-related collisions admitted to the regional trauma centre between 2012 and 2019. The annual incidence of police reported cycling accidents in the region is also shown. Secondary y-axis shows annual incidence of police reported cycling-related trauma across Great Britain during the same period.

Table 2
Patient outcomes by injury type

	Cyclist v Cyclist (n = 29) Group 1	Cyclist v Vehicle (n = 238) Group 2	Fall from cycle (n = 296) Group 3	Overall (n = 553)	P_{KW}	P_{1v2}	P_{1v3}	P_{2v3}
Median ISS	14 (4-29)	23 (4-66)	13 (4-57)	17 (4-66)	<0.001	0.029	1.0	<0.001
Mean GCS	13.5 ± 3.05	12.3 ± 4.07	13.5 ± 2.97	13.0 ± 3.55	<0.001	0.290	1.0	<0.001
Intubation (%)	15.8 (3/19)	34.4 (82/238)	17.9 (53/296)	25.0	NA	0.10	0.82	<0.001

P_{KW} represents the P-value obtained following the Kruskal-Wallis test, P_{1v2} represents the P-value obtained when comparing groups 1 and 2, P_{1v3} represents the P-value obtained when comparing groups 1 and 3 and P_{2v3} represents the P-value obtained when comparing groups 2 and 3. NA: not applicable, this data was categorical and so no Kruskal-Wallis test was performed.

early years of the study, as the majority (40/52, 76.9%) of these 52 accidents occurred between 2012-2014. The exclusion of a greater proportion of patients during this period is likely associated with our centre's change to the use of a new electronic patient record system in October 2014. Prior to this change, it was more difficult to locate detailed patient data, such as injury mechanism and so a greater proportion of patients were excluded.

Assessment upon arrival

Upon arrival to the emergency department, each patient's condition was scored using both the Injury Severity Score (ISS) and Glasgow Coma Scale (GCS) scoring systems. The median ISS and mean GCS scores for the overall cohort were Mean ISS and GCS scores for the overall cohort were 17 (4-66) and 12.8 ± 3.5 (Table 2), respectively. Group 2 was associated with significantly higher media ISS values than Groups 1 (P = 0.029) and 3 (P <0.001). Group 2 GCS values were significantly lower than those in Group 3 (P <0.001).

Investigations and outcomes

Group 2 was also associated with a significantly longer stay in hospital (P<0.001),more operations (P<0.001) and a longer mean time to CT (P<0.001) than group 3 (Table 2). A similar trend was seen when comparing groups 1 and 2, however these comparisons did not reach significance, likely due to a large difference in sample size between the two groups. Group 2 also showed higher rates of intubation and a higher proportion of patients receiving at least one CT scan, when compared to both Groups 1 and 3 (Table 2). Mortality rates were significantly greater in Group 2 when compared to Group 3 (P = 0.009). Group 2 also shows a higher mortality rate when compared to Group 1, with the lack of significance seen when making this comparison again likely due to low num-

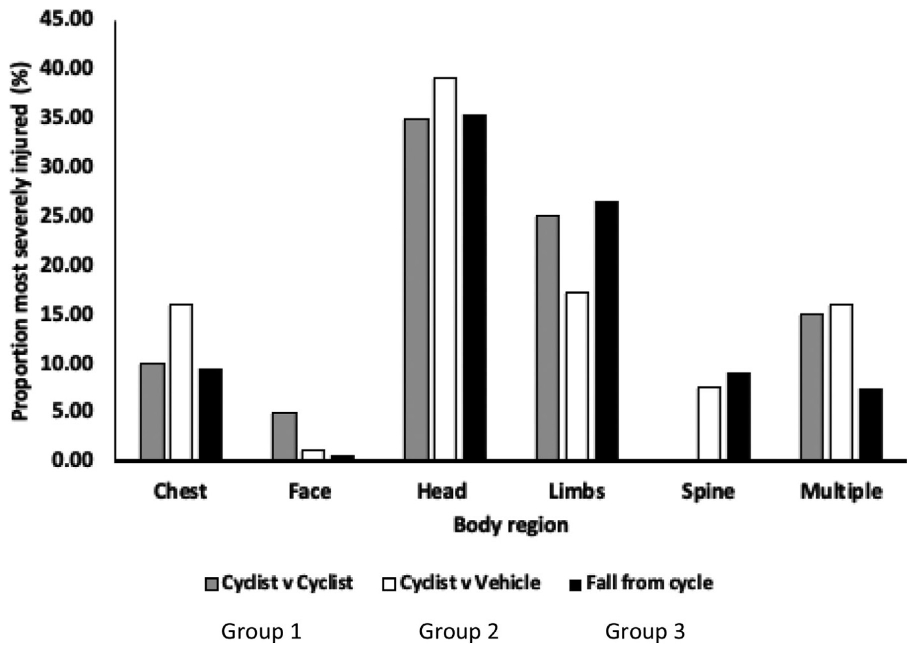

Fig. 2. Most severely injured body region, by injury mechanism.

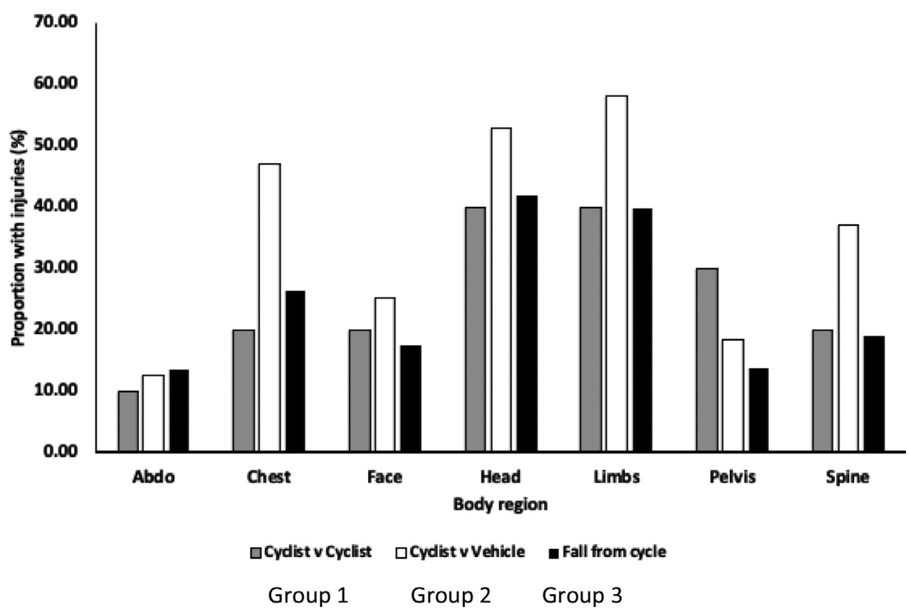

Fig. 3. Frequency of injuries to body regions, by injury mechanism.

bers in the latter group. There was no significant difference between any of these outcome metrics when comparing Groups 1 and 3.

Body regions affected

Using ISS scoring, the most severely injured body region was most commonly the head (45.8%, n = 253/553), followed by the limbs (22.4%, n = 124/553), and least commonly the face (1.1%, n = 6) (Fig. 2). This holds true for all three groups . In the overall cohort, the most commonly injured body regions were the limbs (47.7%, n = 264/554), followed by the head (46.6%, n = 258), chest (35.0%, n = 194), spine (26.7%, n = 148), pelvis (16.4%, n = 91) and abdomen (13.0%, n = 72) (Fig. 3).

Mortality

Twenty (3.6%) patients did not survive to hospital discharge. Of these fatalities, the median age was 55 years (range 11 – 90 years), 19 (95%) had a head injury, 16 (80%) were male and 6 (30%) of the incidents were at night. In terms of injury mechanism, the mortality rate was 0% for Group 1 incidents, 15/238 (6.3%) for Group 2, and 5/296 (1.7%) for Group 3.

Helmet use

The use of a helmet, or lack thereof, was recorded in the medical notes for 211 patients (38.2%). Of these, 111/211 (52.6%) were reported to be wearing a helmet whilst 100/211 (47.4%) were

Table 3
Injury scores and outcomes for helmet users and non-helmet users.

	Helmet users (n = 111)	Non-helmet users (n = 100)	P-value
Proportion sustaining a head injury (%)	34.2% (n = 38)	82% (n = 82)	<0.001
Median ISS score	19 (4-57)	25 (4-57)	0.004
Mean GCS score	13.5 ± 3.35	11.9 ± 4.02	<0.001
Intubation rate (%)	18.0% (n = 20)	40% (n = 40)	<0.001
Mortality rate (%)	3.60% (n = 4)	5% (n = 5)	0.74

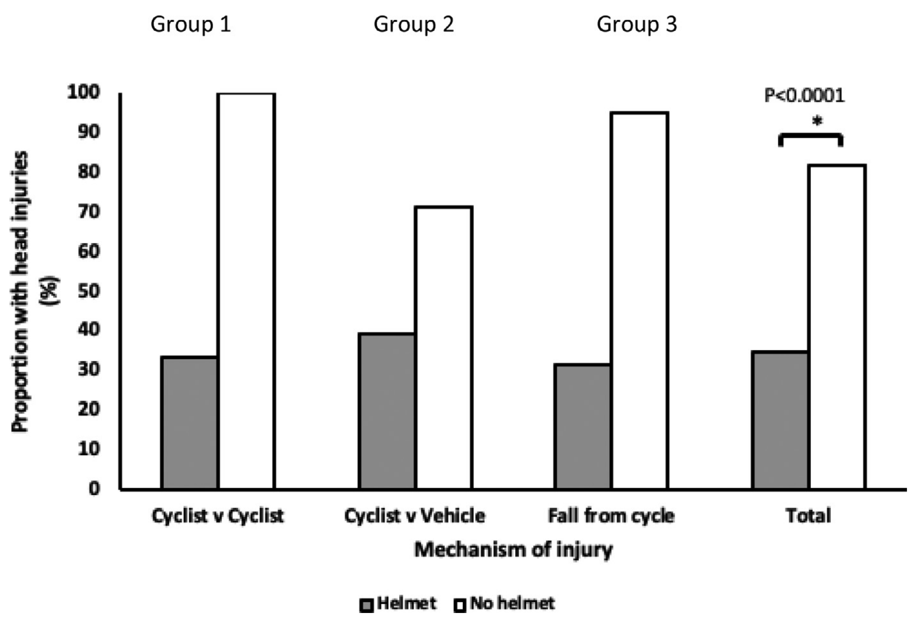

Fig. 4. Proportion of patients with head injuries, grouped by injury mechanism and helmet use.

not (Table 3). This means that in terms of the overall cohort, 111/553 (20.0%), were known to be wearing a helmet during collision, 100/553 (18.1%) were known to not be wearing a helmet, whilst this information was unavailable for 342/553 (61.8%) of patients. Helmet-users were significantly (P<0.001) older (median 50.3 years; range 8.3 – 88.8) than non-wearers (median 38 years; range 8 – 83.7). In both groups, the majority of patients were male, with no significant (P = 0.130) inter-group difference in the male-female proportion.

Outcomes

Of those wearing a helmet, 38/111 (34.2%) sustained a head injury; compared with 82/100 (82%) of those not wearing a helmet (Table 3). This difference showed statistical significance (P <0.001). Helmet use was associated with a lower incidence of head injuries with all three injury mechanisms (Fig. 4). With regards to grading injury severity, helmet use was associated with significantly lower median ISS (19 vs 25, P = 0.004), higher mean GCS (13.5 vs 11.9, P <0.001), and lower intubation rate (P<0.001). Despite these results, there was no significant difference between helmet users and non-users in mortality rate (P = 0.74).

Discussion

This study was undertaken to assess the impact of injury mechanism and helmet use on the outcomes of TARN recorded cycling-related trauma admitted to the regional trauma centre. The majority (55.2%) of the region's population cycle at least once per week – higher than in any other regions [9]. While helmet use has been shown to improve trauma outcomes, only 52.8% of those involved in accidents in this study were reported to be wearing a helmet [12]. These figures raise questions about the relative safety of cycling within this region and other UK regions promoting cycling, and how this might be improved through initiatives, which may include more cycling lanes, and helmet promotion campaigns.

Annual increase in incidents

Although Great Britain saw a steady increase in cyclist traffic across the study period, the total number of cycling casualties nationally, showed a decrease during the same period[2]. This may reflect a 'safety in numbers' phenomenon which is often cited in the literature and reflects a tendency for accidents to increase at a lesser rate than that of traffic volume [13]. This effect may either be due to physical factors, that is, an increased number of cyclists travelling a particular route leads to reduced exposure per cyclist or behavioural factors whereby drivers may be more aware of and careful around cyclists.

It is important to note that the data presented in Fig. 1, showing a decrease in police-reported accidents nationally and in Cambridgeshire, but a rise in the incidence of cycling related hospital admissions, must be interpreted with caution. As shown in this study and others previously, the majority of cycling related injuries admitted to hospital are likely to be falls, which are less likely to be reported to the police, compared to collisions involving other motor vehicles [14]. Therefore, it is possible that there may be an increase in local hospital registered collisions, due to increased cycling and therefore, fall from bike collisions, and a decrease in national police reported collisions, due to improved cycling infrastructure, such as traffic separating cycle lanes, which may decrease the likelihood of a cyclist versus motor vehicle collision [15].

The results of our study indicate that the number of casualties requiring hospital admission for more than three days increased during the study period. It is not clear whether this represents an increase in the overall number of cycling collisions admitted to our hospital, or an increase in the proportion meeting the TARN inclusion criteria. These findings may suggest that, although the number of cycling casualties in Cambridgeshire shows a non-significant decrease across the study period, the safety in numbers effect may not be applicable to all geographical regions and accident severities. We therefore cannot simply rely on such an effect in order to keep cyclists safe. It is crucial that with the likely, government-promoted, increase in cycling uptake, further measures are implemented to ensure safety of cyclists across the country's roads.

Injury mechanism

Group 2 (Cyclist v Vehicle) was associated with higher ISS and lower GCS scores (ISS, GCS), and greater need for intubation than group 3 (Fall from cycle). A similar trend was seen when comparing group 2 with group 1, however this often did not reach significance, likely due to the low patient numbers in group 1. This suggests that collisions with vehicles are associated with the most severe injuries and the worst outcomes. These results agree with previous work such as that of Neumann et al [16]. As such, the interaction between cyclists and motor vehicles should be a priority when designing interventions to reduce cycling-related trauma .

A report on drivers' perceptions of cyclists commissioned by the Department of Education indicated that drivers consider it the 'social norm' to overtake cyclists even in situations where it is recognised that doing so may not be ideal [17] . The recent study of Fruhen et al found that driver's perception of social norms are particularly relevant when it comes to aggressive driving towards cyclists [18]. It is therefore possible that such perceptions could form the psychological basis of any safety intervention aimed at increasing cyclist road safety. Specifically, initiatives could focus on altering perception of social norms and attitude towards cyclists, by combating driver's negative views of cyclists, building awareness of cyclists as equal road users and of the benefits of cycling, such as reducing pollution and congestion. Furthermore, there is currently no requirement for drivers to be tested specifically on their ability to safely interact with cyclists as part of the UK driving test [19]. Adding such an element to the driving test may be worth consideration as a tool to aid in educating drivers as outlined above. However, while such interventions may seem promising, there is currently a paucity of evidence evaluating their efficacy. Further research into the effectiveness of such education initiatives is required, before their use can be strongly justified.

Alongside driver education, cyclist education also appears to be an important factor in accidents. Whilst our study shows that Cyclist v Vehicle accidents are the most serious, Fall from cycle accidents, with no other vehicle involved, were the most common across the 8.5-year study period. In the majority of these cases, no further detail was given regarding the injury mechanism, however in many cases, factors such as icy roads, surface water, potholes and the influence of drugs and/or alcohol were cited. Whilst motorists are subject to penalties including 6 months imprisonment, an unlimited fine and a minimum 1 year driving ban if caught driving over the legal alcohol limit (22-35 micrograms alcohol per 100 millilitres of breath in various regions in Great Britain), the penalties for cyclists are less severe [20]. There is no legal alcohol limit outlined for cyclists in the UK and those deemed to be cycling under the influence, may be subject to a maximum fine of £1000 [21]. Given that research has shown that cyclists under the influence of drugs or alcohol have an approximately four times greater risk of being injured than sober cyclists, increasing the possible penalties may be justified [22]. Furthermore, research has shown that cyclist risk taking behaviour may be associated with an increased likelihood of an accident [6]. It has also been found that cyclist risk taking behaviour is influenced by factors such as knowledge of traffic rules and risk perception [6]. It may therefore be argued that future interventions educating cyclists about traffic rules, how to travel safely and manage potential obstacles and emphasising the importance of not cycling while under the influence of drugs or alcohol, may improve cyclist safety. However, again, there is currently no strong evidence showing that such cyclist education-based interventions are effective and further investigation is required before their use can be advocated [23].

The responsibility for avoiding collisions does not solely lie with cyclists and other interacting road users. Previous work ahs highlighted the contribution of poor road infrastructure and road maintenance to cycling related accidents [23]. It is therefore also important that local and national government take effective steps to improve cycling infrastructure. A number of infrastructure related interventions with the aim of improving cyclist safety have been studied, however the evidence as to their effectiveness is currently limited. For example, Chen et al. examined the effect of cycle lanes on the number of police reported crashes, reporting an increase in crashes with cycle lanes, whereas a similar study by Koorey et al. reported a decrease in accidents [24,25] An alternative strategy may focus on speed restrictions and speed awareness. Evidence from the UK, examining the effect of a reduction in speed limit from 30 to 20 miles per hour, reveals a decrease in cyclist collisions post intervention of 21%, [26,27].

Such road infrastructure interventions have already been implemented in Cambridge. For example, there are numerous cycle lanes and designated cycle routes. However, the results of our study and similar previous work demonstrate an increasing frequency of cycling accidents and so it is clear that more needs to be done. One recent change in Cambridge has involved the construction of the UK's first 'Dutch style' roundabout with a fully incorporated cycle lane at the cost of £2.3 million [28]. However current evidence regarding the safety value of such roundabouts is limited with Jensen et al reporting statistically significant increases in cyclist collisions following the conversion of intersections to roundabouts with different types of incorporated cycle lanes [29] . Further Research must be done to assess the efficacy of various road infrastructure changes and relevant interventions should be implemented in accordance with the results of such studies.

Furthermore, road maintenance related factors such as the presence of potholes and wet, oily or dirty conditions have been described as a significant contributor, particularly in 'fall from bike' or single bicycle crashes[31] . Research shows that these two factors account for between 13 and 19.4% of all fall from cycle injuries [30,31]. Given that fall from cycle is the most common mechanism in a number of cycling accident studies, including our own, this highlights the responsibility that local and national government bears in maintaining safe road conditions for cyclists [14–16].

Helmets

Helmet use was significantly correlated with reduced injury severity at initial assessment (ISS, GCS, fewer head injuries), and reduced need for invasive intervention such as intubation. However, helmet use was low with only 52.6% of patients with helmet use information available, recorded as wearing a helmet. Furthermore, our findings reveal a significantly lower age in the non-helmet wearing group compared to helmet wearers, a finding which is also reported elsewhere [32]. This raises questions regarding the reasons behind the low helmet usage seen, specifically amongst younger people, and how this proportion may be increased as part of future interventions concerning cyclist safety.

Reasons for low helmet usage may include social pressure [33]. Cambridge has a significant student population – accounting for approximately 20% of the population [34]. Klein et al observed a negative correlation between adolescent age and helmet use at a public high school [35]. It may be that a cyclist is less likely to wear a helmet if his/her friends and colleagues do not, and this effect may be reinforced with time. Other cyclists may complain of a lack of comfort when wearing a helmet; mixed evidence regarding efficacy / cyclist overconfidence; and inconvenience [33]. Future research, discerning the primary complaints is important, as it will allow us to focus our interventions more effectively.

Bicycle helmet promotion campaigns may be a strong option, particularly for targeting younger people who are less likely to wear a helmet, according to our results. Hospital-led bicycle helmet promotion campaigns have proved effective in young people and have been shown to translate into fewer cycling-related head injuries. Campaigns may include low-cost purchase schemes and talks at schools [36] . However, the average age of non-helmet wearers in our cohort was 38.7 years and so it is also important to go beyond secondary schools and also target campaigns at universities, higher education colleges and potentially even workplaces. It is important to educate children and young people about the importance of wearing a helmet, as any subsequent uptake in helmet use may then be transmitted inter-generationally.

Another option is the mandating of helmet use, via legislation. A common argument against this is that it may not be effective in reducing serious injuries and may even reduce the number of people cycling, thereby producing a net negative effect on population health. Bicycle helmet legislation has been introduced in Australia and New Zealand, and the reported effect has been mixed, ranging from a deterrence effect [37,38], to a children-only decrease [39], and no detrimental effect [40]. It is likely that mandatory bicycle helmet legislation represents only a small contribution to the attractiveness of cycling, and that other factors (cycle lanes and government campaigns) are confounding.

Limitations

Firstly, Group 1 constituted only 3.4% (n = 19) of the cohort. This limited sample size of Cyclist vs. Cyclist collisions may have hidden weakly significant relationships between the different injury mechanisms and patient outcomes. Furthermore, this study only assessed data from patients who met the TARN criteria: stayed in hospital for three or more nights post-accident; or were admitted to critical care. This may have selected for patients with worse outcomes and more severe injuries in each of the three injury mechanism groups, excluding patients with less serious injuries. This may give an unrepresentative sample of the patient outcomes with each injury mechanism, thereby reducing the accuracy of any significant differences between the three groups.

Secondly, use or non-use of helmets was recorded in 211 patients only, representing just 38.2% of the cohort (n = 211/553). Perhaps the proportion of helmet-users was over-estimated, since the recording of a positive finding (helmet worn at time of incident) may be more likely than that of a negative finding (no helmet worn). The reliability of any correlation between helmet use and patient outcomes would be improved if recording of helmet use was increased, thereby increasing the number of data values. Additionally, the average injury risk among those wearing a helmet may be different to that of those not wearing a helmet, due to changes in risk-taking behaviour while cycling. For example, cyclists not wearing a helmet may take more risks [41], and thus be more likely to sustain severe injuries following an accident. The injury severity may thus not be related directly to helmet use, but instead reflect the risk-taking behaviour of the group.

Finally, due to the fact the date presented in this study was derived from hospital records, limited information was available on the location of collisions and more specific causative factors associated with accidents. This somewhat limits the identification of potential local collision prevention measures.

Conclusions

Cambridge is the cycling capital of the UK and the UK government is embarking on a campaign to increase cycling uptake over the coming years. It is important that, alongside these valuable cycling promotion initiatives, interventions aimed at increasing cyclist safety across the country are also implemented. The findings of this study may be used to help provide focus in guiding any such interventions. A multi-faceted approach could be taken involving both driver and cyclist education, effective road infrastructure changes and widespread helmet wearing promotion, specifically aimed at the younger generation.

Availability of data

Data will not be made available.

Ethics approval

This study was given research and development approval as an audit, by our institution's major trauma audit department, allowing access to data held in the TARN (trauma and audit research network) database, for this purpose.

Consent for publication

Not applicable.

Funding

No funding was received.

Declaration of Competing Interest

All authors declare no conflicts of interest.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.injury.2022.09.016.

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