

Cycling related major trauma in Ireland.

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Cycling Related Major Trauma in Ireland.

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Abstract

Introduction: Cycling as a means of transport or recreational activity is increasing in popularity in Ireland. However, increasing numbers of cyclists may lead to an increased number of bicycle collisions and fatalities. The Road Safety Authority is the statutory body for road safety in Ireland but uses police data alone to collate cycling collision statistics. This may lead to an underestimation of cycling injuries in Ireland. Using hospital statistics may provide a greater understanding of cycling trauma in Ireland.

Objective: The present study examines cycling related trauma in Ireland using the Major Trauma Audit (MTA) data collected via the Trauma and Research Network (TARN) from hospitals in Ireland for the period 2014 to 2016. The database was interrogated for demographics, mechanism of injury, injury characteristics and patient outcomes.

Results: There were 410 cycling collisions recorded in the TARN database which represented 4.4% of trauma captured by TARN for the study period. Of this cohort 79% were male compared with 58% in the overall (TARN) trauma cohort ($p<0.001$) and the median (IQR) age was 43.8 years (31.0, 55.7) which is younger than the median (IQR) of 58.9 (36.2, 76.0) years for the overall trauma cohort ($p<0.001$). Cycling collisions had a median (IQR) injury severity score (ISS) of 10 (9, 20) which was higher than the overall trauma cohort ISS of 9 (9, 17). Of the mechanisms observed for cycling trauma, 31.7% ($n=130$) had a collision with a motor vehicle. Of those who did not wear a helmet, 52.2% ($n=47$) sustained a head injury compared with 27.5% ($n=44$) in the group who were wearing a helmet ($p<0.001$).

Conclusion: The TARN data presented in this paper builds a more complete overview of the burden of cycling collisions in Ireland. Particular points of focus are that serious cycling injuries occur in a predominantly male population, and that only around 30% of cases are recorded as involving a motor vehicle, with the majority having an unknown mechanism of injury. There was an association between helmets and head injuries in this study, but there are likely other contributing factors such as mechanism of injury, velocity or cycling infrastructure. Using hospital data such as the MTA provides valuable information on the injuries sustained by cyclists, but more prospective studies to capture injury mechanism and contributing factors are needed.

Keywords:

Injury prevention; trauma; pre-hospital care; emergency medicine; poly-trauma; cycling; bicycle; tarn; epidemiology; road traffic collisions; road traffic accidents; head injury; helmets; Ireland

Introduction

Cycling as a means of transport or recreational activity is increasing in popularity in the Republic of Ireland (Ireland). The Central Statistics Office (CSO) reported in 2016 a 43% increase in people cycling to work compared to 2011 [1]. Increasing numbers of cyclists may be associated with an increased number of bicycle collisions and fatalities, with nine cycling fatalities reported in 2018 in Ireland [2].

Studies in Germany, Sydney and Hong Kong have reported an increased incidence of cycling injuries and an increasing impact on health services [3-8]. The Road Safety Authority (RSA) is the statutory body for road safety Ireland and reported in 2012 that there were 630 cycling injuries in Ireland [9]. However, the RSA uses police data primarily to collate cycling statistics and this likely underestimates the number of cyclists suffering injuries as has been reported previously.[3, 10-16]. The Hospital In-Patient Enquiry (HIPE) is the principal source of national data on discharges from acute hospitals in Ireland. HIPE collects demographic, clinical and administrative data on discharges from, and deaths in, acute public hospitals nationally [17].

The number of hospital discharges related to road traffic collisions was 3.5 times greater according to HIPE statistics between 2005-2009 than the number reported by the police specifically for the same period [18]. This is likely due to the nature of cycling collisions, which often do not involve a third party, hence rarely resulting in reporting of the incident to the police. If a high number of these unreported cases exist, certain cycling data should be analysed with caution.

There is limited research on cycling injuries in Ireland to date, with published literature focussing predominantly on fatalities associated with road traffic collisions. Previous cycling studies have shown that cycling specific interventions to improve route infrastructure can increase safety and reduce the collision risk for cyclists [14, 19-23]. Without specific injury and collision statistics, it is more difficult to implement effective injury prevention strategies. Therefore, understanding the true burden and trends of cycling collisions may help drive and inform future prevention strategies in Ireland. Collating hospital data may provide a more complete picture and a greater understanding of the extent of cycling injuries, and if there are any preventable contributing factors leading to collisions.

The number of cyclists in Ireland is increasing annually, and there are likely far more cycling collisions than are reported, but little is known of the causative factors and mechanisms involved for cycling collisions in Ireland. This study examines cycling trauma in Ireland using hospital-based statistics and aims to identify predictable and preventable factors associated with cycling collisions.

Methods

This is a retrospective study of cycling related injuries resulting in inclusion on a national trauma registry in Ireland over a three-year period. The National Office of Clinical Audit (NOCA) implemented a Major Trauma Audit (MTA) in Ireland in 2013 using the established Trauma Audit and Research Network (TARN) methodology [24]. Information from all 26 hospitals in Ireland that receive major trauma is collated in this database allowing analysis of processes and outcomes related to trauma care and outcomes.

The MTA captures data on patients of any age who sustain injury resulting in any of: hospital admission >72 hours; intensive care or high dependency admission; transfer to a tertiary/specialist centre and in-hospital death within 30 days. Patients are excluded in the event of: isolated femoral neck fracture in patients >65 years, isolated single pubic ramus fracture in patients >65 years; simple isolated injuries e.g. uncomplicated ulnar fracture; or diagnosed as dead on hospital arrival, with no initiation of treatment [25].

Data coverage refers to the measure of major trauma cases with data entered against the overall expected number of cases (this is also referred to as ‘case ascertainment’ in TARN). The expected number of cases per hospital is estimated based on the HIPE file for each hospital for the previous year. The TARN eligibility criteria for inclusion are applied to the national HIPE file for the previous year and an estimate of expected cases is then generated for each hospital.

During the study period, the audit was still in implementation, meaning that more hospitals were joining the audit, and this impacted the overall coverage for those years. In 2016, all eligible hospitals were submitting data regularly and during that year the MTA was the first audit to achieve National Clinical Effectiveness Committee (NCEC) accreditation and endorsement from the Minister for Health. During implementation, an estimation of the

denominator for each hospital was used from the HIPE system where S and T codes relating to specific trauma types were selected to give an estimation of expected numbers of cases. However, if a case was subsequently identified as not meeting the audit requirements, it could not be removed from the denominator during the study period. In 2017 a new process was implemented to remove these cases. It is not possible to retrospectively adjust the coverage for the previous years.

In addition, there has been increased awareness of the importance of MTA in Ireland as reconfiguration of trauma services is being implemented in Ireland – hospitals have prioritised MTA through supporting and ring-fencing staff to perform the data collection duties. The result of all these initiatives has seen an increase in data capture to 86% in the MTA report published February 2019 [26].

MTA coordinators in member hospitals screen all trauma cases for database inclusion and extract a dataset of demographic, physiological, investigation, and treatment variables from the clinical case notes of eligible patients. Injuries are defined according to the 2005 (2008 revision) Abbreviated Injury Scale (AIS) version 13 dictionary by trained injury coders [27] [28]. Information is submitted using a standard web-based data system. Records for patients undergoing inter-hospital transfer between participating hospitals are matched deterministically using unique patient identifiers. Outcome is assessed in terms of inpatient mortality at discharge or 30 days, whichever occurs first.

TARN uses AIS scores to compute the Injury Severity Score (ISS) [29]. For example, a patient with a fractured femur and large subdural haematoma would be coded and receive an ISS of 34. The most severely injured body region was based on the body area with the highest AIS severity injury in it. For example, a patient with a femoral fracture (limbs, severity 3) and a large extradural haemorrhage (head, severity 5) will have the head as the most severely injured body region.

The MTA data from 1 January 2014 to 31 December 2016 was interrogated to identify all patients who attended an Irish hospital with a cycling related injury. Information including demographics, time of injury, ISS, Glasgow Coma Score (GCS), helmet use, length of stay and intensive care unit admission were extracted. For this study, helmet use was determined by reviewing the MTA data. If helmet usage was not documented in the clinical notes in the

participating hospital, the data was not available. Each circumstance of collision with a known cause is classified into one of the following groups: collision with motor vehicle, collision with fellow cyclist, collision with animal, fall while mountain biking, collision with obstacle and, if a definite cause was not identified from the database, the crash counterpart was determined as "unspecified". Patients in this cohort (Cycling Trauma Group) was then compared with all patients who had suffered a trauma (Overall Trauma Group).

Medians with interquartile ranges are reported for continuous variables with a skewed distribution and compared using a Mann–Whitney U test. In-hospital mortality rates were calculated for group data as well as individual injury mechanisms. Chi-square tests were used to determine associations between categorical variables and age group or outcome with a continuity correction being applied for 2×2 tables. Binomial logistic regression models were generated to ascertain the effects of age, sex, collision mechanism (collision with a vehicle, with another cyclist/pedestrian, or other), and helmet use on the likelihood that cyclists sustained a head injury. For data analysis, we used Statistical Package for Social Sciences (SPSS version 23, IBM, USA). A p-value less than 0.05 was considered statistically significant.

This study received ethical approval from the Research Ethics Committee in St. Vincent's University Hospital, Dublin 4, Ireland.

Results

During the study period, there were 9,312 major trauma cases in the MTA for Ireland representing 65% data coverage; 410 (4.4%) were cycling related. Baseline characteristics of cycling trauma in comparison to the overall group (i.e. all TARN-eligible patients) are displayed in Table 1. 79% of the cycling group were male (324/410) compared to 58% (n=5,401/9,312) in the overall group ($p<0.001$). Gender breakdown by age bands is displayed in Figure 1.

Arrival times to the ED were predominantly "out of hours" with 56% of the cycling group (n=230) and 58% of the overall group (n=5,401) arriving between the hours of 1600 and 0800 ($p=0.40$). The number of cyclists presenting to ED following an injury sustained during "rush-hour" traffic (0700-0900, 1600-1900, Monday to Friday) was 79 (19.3%).

Mechanism of Injury

The circumstances of cycling collisions is shown in Figure 2.

Regarding the “Unspecified” group, a more detailed mechanism of injury was not available (n=173, 42.2%). “Obstacle” includes hitting a pedestrian, sign, kerb, pothole, wall or tree.

Of the cyclists who had a collision during rush hours traffic, 36/79 (45.6%) had a collision with a motor vehicle, compared to 94/331 (28.4%) outside of rush hours (p=0.005).

Helmet Use

Helmet use was documented in 250 cases (61%). Of these, 160 (64.0%) were wearing a helmet. Of those who did not wear a helmet, 47/90 (52.2%) sustained a head injury compared with 44/160 (27.5%) in the group who were wearing a helmet (Figure 3).

Injury

Based on AIS scoring, the most severely injured body region in 25.9% (n=106) of the cycling population was the head. This was followed by limbs (24.1%, n=99), chest (20.2%, n=83), spine (11.2%, n=46), multiple (10.2%, n=42), abdomen (5.1%, n=21) and face (3.2%, n=13). The median GCS was 15 (IQR 15, 15) on arrival to the ED in both the cycling and the overall trauma group. There were 10 cyclists (2.4%) with a GCS of 9-12 and 25 (6.1%) with a GCS of less than 8. GCS was not documented in 15 cases (3.7%). In total there were 130 head injuries (31.7%) with a median AIS of 4 (IQR 3, 5). The factors affecting occurrence of at least AIS 1 (AIS1+), and at least AIS 2 (AIS2+) head injuries were investigated using regression modelling as shown in the supplementary material. The adjusted odds of sustaining a head injury of at least AIS 1 (AIS 1+) were 2.9 times greater for cyclists not wearing a helmet compared to those who did (95% CI:1.7-5.2), and 2.8 times greater for a head injury of at least AIS 2 (AIS 2+) (95% CI:1.5-5.0). The adjusted odds of having a head injury of AIS 1+ was 2.0 times greater for females as opposed to males (95% CI: 1.1-3.7), and 2.1 times greater for a head injury of at least AIS 2 (95% CI:1.1-3.9). Neither age nor mechanism of collision were associated with an effect on the odds of head injury occurrence.

Disposition

81 cyclists (19.8%) were admitted to an intensive care unit (ICU). The median age for cyclists admitted to ICU was 43.3 years (IQR 23.5, 55.1). The median ICU LOS for the cycling trauma group was 3 days (IQR 1,7) and the overall trauma group was 3 (IQR 1,8) ($p<0.01$). Disposition characteristics for cycling trauma versus overall trauma are displayed in Table 2.

309 cyclists (75.5%) had at least one CT scan and 142 (34.6%) had at least one operation. 101 (71.1%) patients underwent orthopaedic surgery as their initial operation, 22 (15.5%) neurosurgery, 6 (4.2%) maxillofacial surgery, 5 (3.5%) general surgery, 5 (3.5%) plastic surgery, 2 (1.4%) cardio-thoracic surgery and 1 (0.7%) had ear, nose and throat surgery.

The outcome was known for 392 cases (95.6%). There were 12 (2.9%) patients who did not survive to hospital discharge. Their median age was 51.5 years (IQR 40.2, 69.4; range 13.8-83.7). Their median ISS was 33 (27, 41.8) and median GCS on arrival was 4 (3, 9). All these patients had a head injury, with 42% ($n=5$) wearing a helmet.

Effects of Age

There were 60 cyclists aged less than 18 years (14.6%), 312 cyclists between 18-65 years (76.1%) and 38 cyclists over the age of 65 years (9.3%). The median ISS was 9 (9, 19) for those under 18 years versus 13 (9,20) in the 18-65 age group and 9 (5,14) for those over 65 years ($p=0.50$). The median LOS was 5 days (3,7) in the under 18 group versus 6 (4, 11) days in the 18-65 age group and 9 (4,14) days in the over 65 group ($p=0.04$). There was 1 mortality (2%) in the under 18 group, 8 mortalities (2.6%) in the 18-65 group and 3 mortalities (8%) in the over 65 group ($p=0.17$).

Discussion

This is the first national study to analyse the numbers and characteristics of serious cycling injuries in Ireland over a 3-year period. Despite the numbers of cycling injuries submitted to MTA as a proportion of all injuries being low as these patients must have injuries of enough severity to meet the TARN inclusion criteria, this study shows that cycling injuries are have significantly higher injury severity scores than the overall trauma population. It also shows that cycling injuries occur in a predominantly young male population and 30% of the

collisions were recorded as involving a motor vehicle. This raises questions about safety for cyclists and whether initiatives such as separating cyclists from motorised vehicles could potentially decrease the risk of cycling collisions.

Cycling trauma represented nearly 5% of the overall major trauma cohort in Ireland for the study period. While it has been shown internationally that the major trauma population is becoming older, cycling trauma primarily affects young males [30, 31].

The MTA Report for 2016 concluded that 40% of all trauma was aged 65 years and older, highlighting that the relative burden of major trauma overall seems to encompass the older population [32, 33]. Within the cycling trauma cohort there was no significant difference between ISS regarding age grouping, but the LOS increased significantly with age. When comparing the cycling group to the overall group, there was a significant difference in ISS, LOS and ICU LOS which could be attributed to the overall age difference between the two groups, and the older group having more co-morbidities, potentially prolonging hospital stay. With an aging population it is likely that cyclists will become older, as has been shown previously and this is an important consideration when planning trauma services [30, 34, 35].

The unspecified collision is not a definitive crash counterpart, but it could be assumed that many of these cyclists had a collision without third party involvement. The isolated “fall from bike” has been reported as an under-recognised cause of cycling injuries and scenarios including loss-of-control events, striking potholes or technical issues with bicycles can be contributory towards collisions. [16, 36-40]. Of the documented known mechanisms, the majority had a collision with a motor vehicle and this has been shown previously to be the most frequent mechanism of severe injury for cycling trauma internationally [31, 41]. That being said, previous studies have shown that 20% of major cycling trauma can occur in marked bicycle lanes, showing that reducing cycling trauma is not simply a case of separating road users but involves other risk reduction strategies, and this also indicates that the cyclist who falls without third party involvement may also be a vulnerable group [16, 36, 40-43].

Severe trauma in Ireland shows little variation in the rate of presentation by day of week or month [33]. However, most cyclists presented to hospital in the summer months, as opposed to a more consistent seasonal distribution of attendances for the overall trauma population. This period is associated with a spike in injuries sustained from other outdoor recreational activities also [44, 45].

Our results show that 19.3% of incidents occurred during rush hours traffic and that there was an association between cycling and motor vehicle collisions during this time period. Previous studies have shown that numerous collisions happen during daylight hours, indicating that there are likely additional reasons for collisions including inadequate cycling infrastructure, lack of safety awareness by other road users and adverse weather conditions [41].

The most severely injured body region in our study population was the head, followed by limbs and chest which correlates with previous international studies [31, 32, 46]. The GCS on arrival of the cycling group was statistically lower than the overall group, but this is likely to be of little clinical significance. It has been reported previously that helmets likely have a protective effect against head injuries [6, 32, 47-51]. Currently, there is no legal requirement to wear a helmet while cycling in Ireland. Helmet status was documented in 61% of cases, and of these 64% were wearing a helmet. Regression modelling has indicated that helmets have a protective effect for this cohort of cyclists who were involved in either off-road or on-road collisions resulting in major trauma, and that females are more likely to sustain a head injury. More research is needed in this area to identify variables which are not included in the study that may contribute to the occurrence of head injuries. It is commonly thought that mandating helmet use may reduce the modal share of cycling and in turn decrease the 'safety in numbers' effect increasing overall collision risk for cyclists, though a recent meta-analysis indicated that this may not be the case [52-54]. The positive effect of mandating helmet use is expected to be greater for jurisdictions with low initial wearing rates, and the use of helmets already is actively encouraged by road safety stakeholders in Ireland leading to a high helmet wearing rate as indicated by this study. This may be sufficient without the need to create a legal imperative. Greater benefits could be expected with provision of greater traffic separation (e.g. cycle lanes), and more forgiving road infrastructure.

The RSA report that there has been a large increase in cycling incidents since 2002 based on Police reporting [55]. This may lead to under-reporting on cycling injuries as has been shown nationally and internationally [3, 10-14, 36, 55-57]. Similarly, this study is limited to the TARN inclusion and exclusion criteria alone, so the cycling population represented here reflects the most seriously injured. Many patients who sustain minor injuries following a cycling collision may well be conservatively managed and not admitted to hospital or not

present to hospital at all [32]. Linking datasets on cycling injuries may help to guide injury prevention strategies in the future.

Data coverage for the study period was 65% which represents a limitation of this study, as the true volume of cycling related trauma may be substantially higher and the incidence rates for this study period may be under-estimated. This has also allowed for selection bias to occur for the cases included, particularly towards the large urban centres where data collection has been consistently high for the study period. The data accreditation was 95.9% indicating excellent data quality when patient information was ascertained.

Conclusion

This study shows that cycling injuries occur in a predominantly young male population and are associated with more severe injuries than the overall trauma population. Only around 30% of cases are recorded as involving a motor vehicle, with the majority having an unknown mechanism of injury. There was an association between helmets and head injuries in this study, but there are likely other contributing factors such as mechanism of injury, velocity or cycling infrastructure. Using hospital data such as the MTA provides valuable information on the injuries sustained by cyclists, but more prospective studies to capture injury mechanism and contributing factors are needed.

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Figures:

Figure 1. Gender breakdown of cycling trauma patients by age band

Figure 2. Circumstances of Cycling Collisions

Figure 3. Helmet use was associated with lower incidence of head injury 27% vs. 52%, $p < 0.001$

Tables:

Table 1. Patient characteristics. Cycling Trauma vs. Overall Trauma in Ireland

Table 2. Disposition characteristics. Cycling Trauma vs. Overall Trauma in Ireland