The Human Impact of Commercial Delivery Cycling Injuries: a Retrospective Cohort Study

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Abstract

Background: Commercial delivery cyclists represent a uniquely vulnerable and poorly understood road user. The aim of this study was to determine whether cyclists could be categorised as commercial or non-commercial from routine medical records and which key demographic, incident and injury characteristics could be identified and attributed to each category.

Methods: Retrospective cohort study of adults presenting to an acute public hospital emergency department between May 2019 and April 2020 after sustaining a cycling-related injury. Multinomial logistic regression was used to examine the demographic, incident, and injury characteristics associated with commercial compared to non-commercial cycling.

Results: Of the 368 people presenting to the emergency department with a cycling-related injury, we were able to categorise 43 (11.7%) as commercial delivery cyclists, 153 (41.6%) as non-commercial cyclists, and the working status of 172 (46.7%) was unable to be confirmed. Both commercial and unconfirmed cyclists were more likely to be younger than non-commercial cyclists. Compared to non-commercial cyclists, commercial cyclists were 11 times more likely to speak a language other than English (AOR 11.3; 95% CI 4.07-31.30; $p < 0.001$), less likely to be injured from non-collision incidents than vehicle collisions (AOR 0.36; 95% CI 0.15-0.91; $p = 0.030$), and were over 13 times more likely to present to the emergency department between 8.00pm and 12.00am compared to the early morning hours (12.00am to 8.00am) (AOR 13.43; 95% CI 2.20-82.10; $p = 0.005$).

Conclusions: The growth of commercial cycling, particularly through online food delivery services, has raised concern regarding commercial cyclist safety. Ongoing surveillance of commercial cyclist injuries is needed to establish the extent and risk factors associated with commercial cycling.

Key Messages Regarding Feasibility

1) What uncertainties existed regarding the feasibility?

It was uncertain whether medical record review could be used to supplement other routinely collected hospital administrative data when categorising cycling injury emergency department presentations as either commercial or non-commercial cycling.

2) What are the key feasibility findings?

Just over half of the cycling injuries were able to be categorised as commercial or non-commercial using routine medical record review.

3) What are the implications of the feasibility findings for the design of the main study?

A substantial proportion of cycling injury emergency department presentations are unable to be categorised as commercial or non-commercial using existing data sources. Targeted data collection in

the form of a prospective observational study and ongoing injury surveillance is required to establish and monitor the extend and risk factors associated with commercial cycling.

Background

Internationally, vulnerable road users have not experienced the same improvements in safety achieved for motor vehicle road users, particularly in car-dependent countries such as the United States (US) and Australia (1, 2). Each year in Australia an average of 38 people are killed and 12,000 injured in transport-related incidents while cycling (3). Concerningly, the rate of cycling-related hospitalisations for major trauma has increased by approximately 8% each year between 2007 and 2015 (2), while the rate of injury-related hospitalisations of other road users has reduced over the same period (2, 3). These findings are consistent with trends observed in similar countries, like the US which experienced an 11% rise in the per-capita cyclist fatality rate between 2010 and 2018 (1).

Rapid growth in the online food delivery industry, particularly in major cities, has driven a rise in commercial delivery cyclists who represent a uniquely vulnerable population of road users (4). Concerns have been expressed regarding poor working conditions, reports of coercion and exploitation, limited training and risks to safety experienced by commercial delivery cyclists (5). Currently, there is limited understanding of the characteristics, behaviours, injuries and health impact of commercial delivery cycling (6–8). It is possible that commercial delivery cycling may introduce additional risk of injury compared to non-commercial cycling, which may influence injury patterns. Commercial delivery cyclists are typically incentivised to perform deliveries quickly (9); their delivery distance range can extend up to 10km (10); and the combination of these two factors can constrain the ability of commercial cyclists to make proactive route choices that would avoid high volume traffic, potentially increasing the risk of motor vehicle collisions compared with people cycling recreationally. One study from New York City, reported that nearly 35% of all injuries sustained while riding a bicycle occurred while working despite there being a mandatory road safety training program for commercial cyclists (11). These commercial cyclists were predominantly young males from minority ethnic backgrounds who were less likely to wear helmets or be distracted by electronic devices (11). However, these findings are likely to be specific to local context and infrastructure, which limits their generalisability and potential relevance to other settings such as Australia. The aim of this study was to determine whether cyclists could be categorised as commercial or non-commercial from routine medical records and which key demographic, incident and injury characteristics could be identified and attributed to each category.

Methods

Design and setting

A retrospective cohort study was conducted at St Vincent's Hospital, Sydney, Australia over a 12-month period (May 2019 to April 2020). The study site was a 400 bed, acute public hospital, which provides a

trauma care service for metropolitan Sydney, including the central business district. The study was approved by St Vincent's Hospital Human Research Ethics Committee (REF 2020/ETH02642).

Study population and sample

All adults aged ≥ 18 years who presented to the hospital emergency department (ED) within the 12-month period were included in the study. Eligible cases were identified from the local trauma registry and ED information system using the search terms “bike”, “cycle”, “push-bike” and “cyclist”. Two investigators (CH and YCP) manually screened records for eligibility and extracted the data into the Research Electronic Data Capture (REDCap) tool for secure storage. Records were excluded if the primary reason for the ED presentation was not cycling-related, for example motorcycle-related transport incidents. Commercial cycling status was unable to be easily distinguished using routinely collected administrative data as these fields often contained incorrect or missing information. Therefore, a manual review of medical records was conducted, supplemented by documentation in the hospital's patient management system (WebDelacy) to distinguish between commercial and non-commercial cycling status.

Commercial cycling status

Cycling-related injuries were categorised as either commercial, non-commercial or unconfirmed working status. Confirmation of commercial cycling was determined if the incident was explicitly documented to have occurred while working, for example “riding for Uber Eats”. Administrative data that indicated the activity at time of injury and financial classification (e.g. workers' compensation) were also used to distinguish between commercial and non-commercial cyclists in some instances.

Cycling was deemed ‘non-commercial’ if the reason for cycling was explicitly outlined as recreational or travel that was not undertaken for occupation, including where the patient's occupation was documented as not related to cycling (e.g. “patient employed as accountant”). Records were assigned as unconfirmed working status when there was no explicit documentation on the reason for cycling, for example “fell off bike”.

Demographic, incident and injury characteristics

Demographic characteristics included the age, sex, primary language, and financial classification (i.e. how the hospital episode was funded). The incident characteristics were place of injury, external cause of injury, motor vehicle type (where applicable), bike type, helmet use, ambulance scene attendance, and ED arrival month and time of day. Injury characteristics included the ED triage category, number of injuries, nature of injury, the Abbreviated Injury Scale (AIS) (12), body region count, Injury Severity Score (ISS) (13), whether trauma team activation was required, operative procedure requirement, initial total Glasgow Coma Scale (GCS) (14), and post-ED disposition.

Management of potential risk of bias

Instances of uncertainty when classifying commercial status were discussed between two investigators (CH and YCP) to reach a consensus. When consensus was not met, a third investigator (LC) was consulted and a final decision on classification was made. A conservative approach was taken towards classification whereby cases were recorded as “unknown working status” if there was any uncertainty.

Data analysis

All analyses were conducted using SAS version 9.4 (SAS Institute, Inc.; Cary, NC). Descriptive statistics were presented as mean and standard deviation or number and percentage. Multinomial logistic regression was performed to examine the relationship between the demographic, incident, and injury characteristics (independent variables) for commercial, non-commercial, and cyclists with an unconfirmed working status (dependent variable) presenting to the ED. Variables were included if they had been previously associated with injuries sustained while commercial delivery cycling (11), were collected in the local trauma registry and were statistically significant during univariate analysis (i.e. age, primary language, injury cause, and time of ED arrival). A forward stepwise regression was used to select variables that significantly contributed to the model. Two-way interactions were also examined. Statistical significance was set at a p-value ≤ 0.05 . Effect size was presented as an adjusted odds ratio (AOR) with 95% confidence intervals (CI).

Results

Of the 368 cycling-related ED presentations, we were able to categorise 43 (11.7%) as commercial delivery cyclists, 153 (41.6%) as non-commercial cyclists, and the working status of 172 (46.7%) was unable to be confirmed. Most people injured were male regardless of their working status. The commercial cyclists had a lower mean age and fewer spoke English as their primary language, compared to both the non-commercial cyclists and cyclists with an unconfirmed working status. ED presentations were predominantly government funded through Medicare for both the non-commercial cyclists and cyclists with an unconfirmed working status; however, the commercial cyclists' were more often funded by the compulsory third-party insurance scheme (Table 1).

Table 1

Demographic characteristics of injured cyclists presenting to a hospital ED by working status, May 2019 to April 2020

Characteristic	Commercial cycling (n = 43)	Non-commercial cycling (n = 153)	Unconfirmed commercial cycling (n = 172)
Age, mean (SD)	26.14 (7.9)	46.23 (14.5)	38.00 (13.5)
Sex, n (%)			
Male	31 (72.1)	119 (77.8)	135 (78.5)
Female	12 (27.9)	33 (21.6)	35 (20.4)
Indeterminate/Intersex/Unspecified	0 (0.0)	1 (0.7)	2 (1.2)
Primary language, n (%)			
English	11 (25.6)	140 (91.5)	127 (73.8)
Spanish	10 (23.3)	8 (5.2)	23 (13.4)
Other	21 (48.8)	5 (3.3)	22 (1.2)
Financial class, n (%)			
Public, Medicare	3 (6.9)	99 (64.7)	83 (48.3)
Private	0 (0.0)	15 (9.8)	7 (4.1)
Workers' compensation	8 (18.6)	0 (0.0)	0 (0.0)
Compulsory third party insurance	16 (37.2)	29 (18.9)	50 (29.1)
Overseas visitor	5 (11.6)	6 (3.9)	5 (2.9)
Medicare ineligible patient	11 (25.6)	4 (2.6)	27 (15.7)

Non-collision-related cycling incidents (e.g. falling while getting on or off bicycle) were among the most frequent injury mechanism for all three cycling categories, although non-collisions were more common for non-commercial (54.3%) compared to commercial (34.9%) cyclists. There was a larger proportion of commercial cyclists who were injured while riding on a roadway and struck by a motor vehicle than non-commercial cyclists or those with an unconfirmed working status. Commercial cyclists were also more often wearing a helmet and using an E-bike than both non-commercial cyclists and those with an unconfirmed working status (Table 2). The number of ED presentations across each month of the year and time of day are presented in Figs. 1 and 2, respectively.

Table 2

Incident characteristics of injured cyclists presenting to a hospital ED by working status, May 2019 to April 2020

Characteristic	Commercial cycling (n = 43)	Non-commercial cycling (n = 153)	Unconfirmed commercial cycling (n = 172)
Repeat ED presentations, <i>n</i> (%)	8 (18.6)	18 (11.8)	18 (10.5)
Ambulance scene attendance, <i>n</i> (%)	15 (34.9%)	60 (39.2%)	53 (30.81%)
ED triage category, <i>n</i> (%)			
Category 1 ^a	3 (6.9)	13 (8.5)	18 (10.5)
Category 2 ^b	11 (25.6)	35 (22.9)	39 (22.47)
Category 3 ^c	10 (23.3)	53 (34.6)	47 (27.3)
Category 4 ^d	17 (39.5)	46 (30.1)	59 (34.3)
Category 5 ^e	0 (0.0)	1 (0.7)	2 (1.2)
Not specified	2 (4.7)	5 (3.3)	7 (4.1)
Place of injury, <i>n</i> (%)			
Driveway to home	0 (0.0)	3 (1.9)	1 (0.6)
Roadway	26 (60.5)	63 (41.2)	65 (37.8)
Sidewalk	1 (2.3)	6 (3.9)	7 (4.1)
Cycleway	1 (2.3)	4 (2.6)	0 (0.0)
Other roadway	6 (13.9)	27 (17.7)	37 (21.5)
Parking lot	0 (0.0)	1 (0.7)	0 (0.0)
Other	0 (0.0)	16 (10.5)	2 (1.2)

^a injuries immediately life threatening

^b imminently life-threatening, important time critical condition

^c potentially life-threatening, situational urgency

^d potentially serious, situational urgency, complex presentation

^e less urgent, clinical administrative

Characteristic	Commercial cycling (n = 43)	Non-commercial cycling (n = 153)	Unconfirmed commercial cycling (n = 172)
Not specified	8 (18.6)	33 (21.6)	61 (35.5)
Injury cause, <i>n</i> (%)			
Collision	24 (55.8)	51 (33.3)	73 (42.4)
Non collision	15 (34.9)	83 (54.3)	69 (40.1)
Other and unspecified	4 (9.3)	19 (12.4)	30 (17.4)
Motor vehicle involved in incident, <i>n</i> (%)			
Car	13 (30.2)	36 (23.5)	52 (30.2)
Other (truck, bus, motorbike, scooter, taxi)	3 (6.9)	2 (1.3)	6 (3.5)
Not documented/not Specified	2 (4.7)	3 (1.9)	18 (10.5)
No vehicle	25 (58.1)	112 (73.2)	96 (55.8)
Helmet use, <i>n</i> (%)			
Yes	30 (69.8)	101 (66.0)	95 (55.2)
No	0 (0.0)	4 (2.6)	13 (7.6)
Unknown	13 (30.2)	48 (31.4)	64 (37.2)
Bike type, <i>n</i> (%)			
Push bike	33 (76.7)	140 (91.5)	144 (83.7)
E-bike	7 (16.3)	4 (2.6)	17 (9.9)
Unknown	3 (6.9)	7 (4.6)	11 (6.4)
^a injuries immediately life threatening			
^b imminently life-threatening, important time critical condition			
^c potentially life-threatening, situational urgency			
^d potentially serious, situational urgency, complex presentation			
^d less urgent, clinical administrative			

All cycling categories had a higher proportion of non-orthopaedic injuries (e.g. lacerations, abrasions, soft tissue) and injuries to the extremities or pelvic girdle body regions. An ISS was available for one-third of

records; of those, non-commercial cyclists (9.27) had higher mean ISS and a smaller proportion of minor injuries (53.3%) compared with commercial cyclists (3.25 and 100% respectively). Non-commercial cyclists received operative procedures more frequently than commercial cyclists. Commercial cyclists were more often discharged from the hospital ED with their treatment completed; although, they (18.6%) re-presented to the ED more often than both the non-commercial cyclists (11.8%) and those with an unconfirmed working status (10.5%). (Table 3).

Table 3

Injury characteristics of injured cyclists presenting to a hospital ED by working status, May 2019 and April 2020

Characteristic	Commercial cycling (n = 43)	Non-commercial cycling (n = 153)	Unconfirmed commercial cycling (n = 172)
Number of injuries, <i>n</i>	59	225	246
Nature of injury, <i>n (%)</i> *			
Head ^a	10 (16.95)	33 (14.7)	37 (15.0)
Chest/abdominal ^b	0 (0.00)	18 (8.0)	14 (5.7)
Orthopaedic ^c	9 (15.25)	71 (31.6)	62 (25.2)
Other non-orthopaedic ^d	40 (67.80)	103 (45.8)	133 (54.1)
Number of body regions injured, <i>n</i>	63	248	267
ALS body region, <i>n (%)</i> [†]			
Head or neck	10 (15.87)	37 (14.9)	42 (15.7)
Face	10 (15.87)	30 (12.1)	26 (9.7)
Chest	1 (1.59)	23 (9.3)	18 (6.7)
Abdominal or pelvic contents	0 (0.00)	4 (1.6)	7 (2.6)
Extremities or pelvic girdle	34 (53.97)	119 (47.9)	127 (47.6)
External ^e	10 (15.87)	35 (14.1)	45 (16.9)
Injury severity score available ^f , <i>n (%)</i>	12 (27.91)	45 (29.4)	63 (36.6)
Injury severity score, <i>mean (SD)</i>	3.25 (1.96)	9.27 (6.2)	5.40 (4.6)
Mild (< 9), <i>n (%)</i>	12 (100)	24 (53.3)	48 (76.2)
Moderate (9–15), <i>n (%)</i>	0 (0.0)	14 (31.1)	11 (17.5)
Severe (16–25), <i>n (%)</i>	0 (0.0)	7 (15.6)	4 (6.3)
Profound (> 25), <i>n (%)</i>	0 (0.0)	0 (0.0)	0 (0.0)
Trauma team consult ^g , <i>n (%)</i>	12 (27.91)	48 (31.4)	58 (33.7)

Characteristic	Commercial cycling (n = 43)	Non-commercial cycling (n = 153)	Unconfirmed commercial cycling (n = 172)
Operative procedure required ^h , n (%)	5 (11.63)	24 (15.7)	18 (10.5)
GCS, mean (SD)	14.97 (0.17)	14.87 (0.4)	14.95 (0.3)
Post ED disposition, n (%)			
Discharged - treatment completed	34 (79.1)	99 (64.7)	112 (65.1)
Discharged - did not wait	1 (2.3)	5 (3.3)	9 (5.2)
Discharged - against advice	0 (0.0)	3 (1.9)	8 (4.7)
Admitted to acute hospital	7 (16.3)	39 (25.5)	35 (20.3)
Transferred to other facility	1 (2.3)	2 (1.3)	7 (4.1)

*Refers to count of nature of injury categories.

[†]Refers to count of injuries sustained in regions outlined abbreviated injury scale body regions.

^aInjuries involving cranial structures, such as post-trauma headaches, skull fractures, intracranial haemorrhage.

^bInjuries involving the chest, chest wall and abdominal structures, such as intraabdominal bleeds, rib fractures and pneumothorax.

^cInjuries such as fractures to extremities.

^dInjuries such as lacerations, abrasions, contusions and sprains.

^eAIS denotes classifying abrasions and lacerations as external. When the location of injury was explicitly stated we categorised injuries such as abrasions and lacerations under the body region stated in medical notes and categorised as external if not stated.

^f89 records excluded due to blank score.

^gRecords ranged from consult with trauma staff to full trauma team activation.

^hRecorded if referred to operating suite for injuries sustained while cycling.

Both commercial cyclists and cyclists with an unconfirmed working status who were injured and presented to the hospital ED were significantly more likely to be younger than non-commercial cyclists.

Compared to non-commercial cyclists, commercial cyclists were 11 times more likely to speak a language other than English (AOR 11.3; 95% CI 4.07–31.30; $p < 0.001$) and cyclists with an unconfirmed working status were more than twice as likely to speak a language other than English (AOR 2.60; 95% CI 1.26–5.38; $p = 0.010$). Commercial cyclists were less likely to be injured from non-collision incidents than collisions with vehicles, compared with non-commercial cyclists (AOR 0.36; 95% CI 0.15–0.91; $p = 0.030$) as cyclists with an unconfirmed working status (AOR 0.51; 95% CI 0.30–0.86; $p = 0.011$). Commercial cyclists were around 13 times more likely than non-commercial cyclists to present to ED between 8.00pm and 12.00am compared to the morning time period between 12.00am and 8.00am (AOR 13.43; 95% CI 2.20–82.10; $p = 0.005$). Similarly, cyclists with an unconfirmed working status were more than 2.5 times more likely than non-commercial cyclists to present to ED between 8.00pm and 12.00am compared to the morning period between 12.00am and 8.00am (AOR 2.67; 95% CI 1.06–6.77; $p = 0.038$) (Table 4).

Table 4

Multinomial logistic regression of demographic, incident, and injury characteristics by commercial cycling status

Characteristic	Commercial cycling (n = 43)	Unconfirmed commercial cycling (n = 172)
	Adjusted odds ratio & 95% CIs ¹	Adjusted odds ratio & 95% CIs ¹
Age group		
18–24	1	1
25–34	0.22 (0.07 to 0.71), 0.011	0.49 (0.19 to 1.28), 0.146
35–54	0.04 (0.01 to 0.19), 0.000	0.40 (0.16 to 1.03), 0.057
55+	0.03 (0.00 to 0.29), 0.002	0.19 (0.07 to 0.55), 0.002
Primary language		
English	1	1
Other	11.25 (4.06 to 31.19), 0.000	2.60 (1.26 to 5.38), 0.010
Injury cause		
Collision	1	1
Non-collision	0.36 (0.15 to 0.91), 0.030	0.51 (0.30 to 0.86), 0.011
Other and unspecified	0.74 (0.21 to 2.57), 0.637	1.00 (0.50 to 1.98), 0.999
ED arrival time		
Midnight-0759	1	1
0800–1459	4.45 (0.76 to 26.13), 0.098	1.30 (0.63 to 2.66), 0.479
1500–1959	4.51 (0.77 to 26.26), 0.094	1.78 (0.82 to 3.86), 0.143
2000–2359	13.43 (2.20 to 82.10), 0.005	2.67 (1.06 to 6.77), 0.038
¹ Non-commercial cycling was the referent group.		

Discussion

This is the first study exploring the impact of the food delivery gig-economy and commercial cycling in the Australian context. This study demonstrated that just over half of the cycling injuries presenting to the emergency department during the study period were able to be categorised as either commercial or non-commercial. Commercial cyclists share distinct demographic, incident and injury patterns that differ from non-commercial cyclists. Commercial and unconfirmed cyclists were more likely than non-commercial

cyclists to be younger, speak a language other than English, and present to ED after injury in the evening (8.00pm to 12.00am) compared to the morning (12.00am to 8.00am). Commercial cyclists and cyclists with an unconfirmed working status were both comparatively more likely to be injured from collision with a vehicle than non-commercial cyclists.

The current study is concordant with previous claims that much of the commercial delivery cycling workforce is comprised of temporary migrants on students visas in Australia (15). In New South Wales, Australia, employees are entitled to a form of insurance payment if they are injured at work (i.e. workers' compensation). However, many online food delivery companies classify their delivery cyclists not as employees but independent contractors who are responsible for their own insurance and other work-related costs. The implications of which appear to shift the funding of health-related costs from injuries obtained during the conduct of work from the workers' compensation scheme to other funding mechanisms, such as compulsory third-party insurance for those injured in a motor vehicle incident or hospitals bearing the costs of Medicare ineligible patients (i.e. non-compensable). The current study findings provide some support for the claim that treatment costs of injuries sustained while engaged in commercial cycling were likely to be subsumed by government, the injured individual or their private insurer, rather than their employer.

The current study highlights the need for improving data capture to better distinguish between commercial and non-commercial cyclists. Information obtained from the "activity when injured" and "financial classification" fields within the routinely collected hospital administrative registry data (16) was not adequate to identify commercial cyclists, requiring the research team to conduct a medical record review. Even by doing so, nearly half of cycling injury ED presentations were unable to be categorised as work-related or not. This constrains the ability of government regulatory agencies, employee representatives, and the online food delivery companies to conduct surveillance of injuries and accurately evaluate the impact of occupational safety improvement programs for commercial delivery cyclists (17).

The high proportion of motor vehicle collisions experienced within this cohort and the broader recreational cycling population indicates a need for improvements in road safety for vulnerable road users. Improved active transport infrastructure and street design, including integrated, connected and convenient facilities with physical separation from motor vehicles has been recommended from extensive international research (18, 19). Injury from active transport is less likely to occur at lower motor vehicle speeds (20, 21), lending support for lower speed limits and traffic calming road modifications. Beyond infrastructure, enforcement of traffic laws that consider the position of vulnerable road users and target distracted and drink driving have been identified as important factors accounting for the difference in road safety for vulnerable road users between high-income countries (22, 23). Encouraging smaller vehicles may also offer an improved safety dividend for vulnerable road users, as larger vehicle size has been associated with more severe injury and death in collisions with both cyclists and pedestrians (24). Finally, traffic education for road users might also contribute to improved safety, however no high quality evidence was identified that might reduce commercial delivery cyclists' collision-related injuries,

particularly as their cycling behaviour is thought to be incentivised by competition around speed of delivery (25).

This study was subject to several limitations. Medical records were limited to a single site over a 12-month period. The sample size and inability to categorise a substantial portion of cyclists as either commercial or non-commercial mean that the study findings should be interpreted with caution. Multiple variables were treated conservatively and recorded as unknown where explicit detail was not available from the medical record. Discerning a validated ISS was also limited to the participants drawn from the local trauma registry for whom the ISS had already been calculated (~ 33% of the included records). Further research is required to understand the health-related impact of commercial cycling injuries more fully in Australia and internationally. A prospective observational study of injured cyclists across multiple sites is required to classify commercial and non-commercial injuries accurately and completely, which would be a pre-requisite to designing and evaluating programs to improve occupational safety for these workers.

Conclusion

The growth of commercial cycling, particularly through online food delivery services, has raised concern regarding commercial cyclist safety. It is difficult to categorise cycling injuries as either commercial or non-commercial using routinely collected administrative data and medical record review. Yet, key differences in the demographic, incident and injury characteristics between commercial and non-commercial cyclists were still able to be identified, which has implications for efforts to improve road safety for these uniquely vulnerable road users. Key data gaps in the injury surveillance of commercial delivery cyclists constrain the ability to accurately design and evaluate the impact of occupational safety improvement programs for this population. Future research is required for ongoing surveillance of commercial cyclist injuries to establish the extent and risk factors associated with commercial cycling.

Abbreviations

AOR – adjusted odds ratio

CI – Confidence Interval

US – United States

ED – Emergency Department

AIS – Abbreviated Injury Scale

ISS – Injury Severity Score

GCS – Glasgow Coma Scale

Declarations

Ethics approval and consent to participate

The study was approved by St Vincent's Hospital Human Research Ethics Committee (REF 2020/ETH02642). A waiver for individual participant consent was granted.

Consent for publication

Not applicable

Availability of data and materials

The datasets analysed during the current study are not publicly available due to ethical approval conditions that are designed to protect the potential re-identification of patients. Please contact the corresponding author regarding reasonable requests for data.

Competing interests

The authors declare that they have no competing interests

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Authors' contributions

MNS: conceptualisation, methodological design, project administration, data collection, analysis, first manuscript draft, manuscript feedback and editing.

LJC: Methodological design, project administration, data collection, manuscript feedback and editing.

CTS: Methodological design, project administration, data collection, manuscript feedback and editing.

KM: Methodological design, project administration, manuscript feedback and editing.

MN: Methodological design, project administration, manuscript feedback and editing.

CH: Data collection, first manuscript draft.

Y-CP: Data collection, first manuscript draft.

RPL: Methodological design, analysis, manuscript feedback and editing.

RM: Methodological design, analysis, manuscript feedback and editing.

All authors read and approved the final manuscript.

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Figures

Figure 1

Number of injured cyclists presenting to the emergency department by month and working status, May 2019 to April 2020

Figure 2

Number of injured cyclists presenting to the emergency department by time of day and working status, May 2019 to April 2020

Supplementary Files

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