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Comparison of the number of pedestrian and cyclist injuries captured in police data compared with health service utilisation data in Toronto, Canada 2016–2021

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ABSTRACT

Introduction Pedestrian and cyclist injuries represent a preventable burden to Canadians. Police-reported collision data include information on where such collisions occur but under-report the number of collisions. The primary objective of this study was to compare the number of police-reported collisions with emergency department (ED) visits and hospitalisations in Toronto, Canada.

Methods Police-reported collisions were provided by Toronto Police Services (TPS). Data included the location of the collision, approximate victim age and whether the pedestrian or cyclist was killed or seriously injured. Health services data included ED visits in the National Ambulatory Care Reporting System and hospitalisations from the Discharge Abstract Database using ICD-10 codes for pedestrian and cycling injuries. Data were compared from 2016 to 2021.

Results Injuries reported in the health service data were higher than those reported in the TPS for cyclists and pedestrians. The discrepancy was the largest for cyclists treated in the ED, with TPS capturing 7.9% of all cycling injuries. Cyclist injuries not involving a motor vehicle have increased since the start of the pandemic (from 3629 in 2019 to 5459 in 2020 for ED visits and from 251 in 2019 to 430 for hospital admissions).

Implications While police-reported data are important, it under-reports the burden. There have been increases in cyclist collisions not involving motor vehicles and decreases in pedestrian injuries since the start of the pandemic. The results suggest that using police data alone when planning for road safety is inadequate, and that linkage with other health service data is essential.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Studies from around the world, including in Australia, the USA and New Zealand, have consistently identified differences between health services data and police data on cyclist and pedestrian injuries.

WHAT THIS STUDY ADDS

⇒ This study adds information about differences between health services and police data between cyclist injuries involving a motor vehicle collision and those that do not. Further, we were able to capture changes in injuries for cyclist and pedestrian injuries over time, and to assess the impact of the pandemic on these injuries.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ This study was requested by the City of Toronto, and they are using the results to plan road safety changes, including to cycling infrastructure that is not on the roadway. Two other regions have recently requested the same data to inform their planning.

INTRODUCTION

Pedestrian and cyclist injuries represent an important burden to Canadians. Systematic reporting of injury rates is not available, and concern about pedestrian and cyclist injuries has been raised by advocates and the media recently. The City of Toronto, Ontario has adopted the Vision Zero Road Safety approach, with the goal of zero killed or seriously injured (KSI) road users; however, the rate of pedestrian and cyclist injuries remains unacceptably high.[1 2]

Collision data are often used as the foundation of the transportation safety planning.[3] In the most cities, police-reported traffic collision data remain the main source for road injury research and traffic safety decisions including in Toronto, Canada.[4] Previous studies comparing police records and hospital data point to under-reporting for pedestrian and cycling injuries in police datasets in European countries, the USA, Australia, New Zealand and Quebec.[5–10] Although there have been no recent studies conducted in Toronto, under-reporting has been cited as a major concern. Less serious collisions are sent to collision reporting centres and many do not get reported to the police.[11] According to a report to the Toronto Police Services (TPS) Board, police reports include around 75%–86% of cycling injuries.[11] This is likely to be an underestimate of how many injuries are missed as other studies around the world have reported the proportion of injured cyclists captured in police data ranged from 7% to 66%.[12] A study in Vancouver reported that fewer than 20% of cycling collisions were reported to the police.[13] Under-reporting of cyclist collisions is most pronounced for those of lower severity, for children, and when a motor vehicle is

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not involved.[6 12–16] Under-reporting of pedestrian collisions is more common for children, particularly those less than 4 years of age; collisions in driveways, sidewalks and parking lots; and collisions in which the car was reversing.[10 16–18] The COVID-19 pandemic may have affected changes in travel patterns and mode choices as well as the police response to collisions.

The objective of this study is to compare the numbers of injuries to cyclists and pedestrians using three data sources; police-reported collisions, emergency department (ED) visits and hospitalisations prior to and after the beginning of the COVID-19 pandemic. A secondary objective is to assess whether the trend over time differs between cyclist injuries involved in a motor vehicle collision (MVC) compared with those who were not (referred to as non-MVC henceforth).

METHODS

Data sources

We compared data for pedestrian and cyclist injuries from 2016 to 2021 from three sources, namely police-reported data from the TPS, ED data from the National Ambulatory Care Reporting System (NACRS) and hospitalisation data from the Discharge Abstract Database (DAD). The DAD is a subset of the NACRS data, including only those patients admitted to the hospital for at least one night. The NACRS and DAD data were requested by the City of Toronto, Transportation Services through the ICES Applied Health Research Question (AHRQ) programme, which provides timely and relevant data to policy-makers across Ontario to assist with decision-making and the formulation of policy.[19] According to the Ministry of Health, 'an AHRQ is a question posed by a health system policy-maker or provider in order to obtain research evidence to inform planning, policy and programme development that will benefit the entire Ontario health system.'[19] A request for these data was initiated by the City of Toronto.

Police-reported data

Cyclist and pedestrian collision data from 2016 to 2021 were provided by the TPS from the Department of Transportation Data and Analytics at the City of Toronto. Data included geographical location coordinates, date and injury severity (none, minimal (no hospital visit, eg, minor abrasions, bruises), minor (medical attention without hospital admission), major (hospital admission, eg fracture, internal injury, severe cuts, concussion) and fatal. We excluded those categorised as 'none' and 'minimal' from our analyses as, by definition, they do not involve a hospital visit. The major and fatal two categories are usually referred to as KSI under the Vision Zero Road Safety Plan, and we will use this terminology henceforth. Police data include all collisions regardless of the address of the injured pedestrian or cyclist or if the outcome was a fatality at the scene, thus captures a somewhat different population than included in the health services data.

ED visits from the NACRS and the DAD

The Canadian Institute for Health Information NACRS and DAD databases are routinely collected administrative health services database that capture outpatient and inpatient visits in a variety of contexts in Ontario.[20 21] For this study, we limited NACRS data to patients presenting directly (not transferred) to an ED. In order to capture pedestrians and cyclists injured in the City of Toronto, we limited our inclusion criteria to patients with a valid Ontario health card number, whose home address' postal code started with an M (City of Toronto), and some L (postal codes that we assumed represented cyclists and pedestrians who commuted into the city from the surrounding suburbs). All of the patients were treated at a hospital whose postal code also started with an M. We assumed that this was most likely to capture Toronto residents who were walking or cycling in Toronto when they were injured, and that this would exclude Toronto residents injured elsewhere (eg, while mountain biking outside the city). The data included records meeting the case definition and included aggregate data for cyclists' injuries (MVC and non-MVC separately) and pedestrian injuries from 2016 to 2021. Pedestrian injuries were classified as those with any ICD-10 code (up to 10 diagnoses per ED visit) starting with 'V0'. Cyclist non-MVC was classified as records with any ICD-10 code starting with 'V10–V19'. Cyclist MVC was classified as those with any ICD-10 code starting with 'V12, V13, V14'. Patients included in the DAD were those who first were identified in NACRS from an ED visit and were subsequently admitted from the ED to an inpatient unit in the hospital. We assumed that patients included in the DAD were more seriously injured than those in NACRS because they required hospital admission, rather than an ED visit alone. The codes were based on the external cause of injury reported in the hospital record and would not include other causes of injury such as falls in the roadway. Neither database would capture cyclists and pedestrians pronounced dead at the scene and not transported to hospital.

Statistical analysis

Counts of MVC and non-MVC cycling injuries by year were calculated for 2016–2021. The TPS-coded injuries (all minor, major and fatal injuries) were compared with the NACRS ED visits. The TPS major and fatal injuries (KSIs) were compared with the DAD hospital admissions. We compared these data for all cyclist injuries, and then for cyclist MVC injuries. We limited the comparison with the DAD to those with serious (KSI) injuries as identified in the TPS data because we felt that it would be more representative than including all injuries. Finally, in recognition of changing travel patterns during the COVID-19 pandemic, we also noted differences in the time prior to COVID-19 to the two initial years of the pandemic (2020 and 2021). We assessed changes in the number of injuries over time using the beta coefficient of the line of best fit for trend. The purpose of the trend line was to assess the direction and magnitude of the changes over time and although there were greater changes to the health services data immediately during COVID-19, the graphs indicated a fairly linear trend. We decided to use count data rather than rates because the denominator for the data sets are not the same. Police data include all collisions where police responded, whereas the NACRS and DAD data include all injuries treated in an ED or hospitalised, regardless of whether the police responded to a collision. We did not have access to home addresses within police data, so cyclists and pedestrians injured in a collision in Toronto may reside outside of the postal codes included in the health services data.

RESULTS

There were 2362 cyclist injuries (minor, major and fatal) reported by the TPS for all cyclist collisons (both MVC and non-MVC) and 30 101 ED visits for all cyclist injuries over the 6-year period (table 1). Therefore, examining trends using police data alone would include only 8% of ED visits. The highest number of all cyclist ED visits occurred in 2020 with the start of the pandemic (n=5999). This pattern differed for the TPS data with the highest number of injuries in 2016 (n=561).

Table 1 Number of police-reported injuries for all cyclist injuries, compared with injury ED visits and hospital admissions, 2016–2021

Year	Police reported (minor, major and fatal)	ED visits	% Police reported versus ED visits	Police-reported killed or seriously injured	Hospitalisations	% Police reported versus hospitalisations
2016	561	5391	10.4	38	427	8.9
2017	422	4738	8.9	52	319	16.3
2018	358	4368	8.2	44	305	14.4
2019	336	4261	7.9	46	314	14.7
2020	337	5999	5.6	32	503	6.4
2021	348	5344	6.5	21	431	4.9
Total	2362	30101	7.9	233	2299	10.1

ED, emergency department.

There were 233 KSI cyclist injuries reported by police, while there were 2299 hospital admissions—police data represented 10% of injuries (table 1). The highest number of hospital admissions occurred in 2020 (n=503) but in the police data, the highest numbers occurred in 2017 (n=52). Although both data sets indicated a reduction, the reduction in police data was smaller (average injury reduction per year 38.4) compared with the ED visit data (average injury reduction per year 63.3). The same is true for the KSI and hospitalisations (reduction of 4.1 and 2.1, respectively).

Table 2 portrays the number of cycling MVC and non-MVC injuries. Throughout the study period, most cyclist injuries were non-MVC, with only 16.0% of ED visits and 19.9% of hospital admissions being cycling MVC injuries. After the start of the COVID-19 pandemic, cycling MVC ED visits decreased by 17% compared with the previous 4-year average, and non-MVC ED visits increased by 38%, and hospital admissions for MVC decreased by 15% while non-MVC admissions increased by 61%. The trends for cyclist MVC injuries showed an average yearly decrease of 63 injuries treated in the ED, and a decrease of 2 injuries in the hospitalisation data. The non-MVC injuries in the ED went up by a yearly average of 162 with an increase of 19 hospitalisations each year.

For cyclist MVC injuries, the number of injuries captured was closer than for non-MVC visits for both ED and hospitalisation. For all injuries police data represented 58.8% of ED visits, and for serious injuries police data. Police data represented 52.6% of hospitalisations.

For pedestrians, the police data represented 53.7% of ED visits and 48.4% of hospitalisations (table 3). Pedestrian injuries have decreased in all three datasets since 2020. However, the magnitude of the difference was not the same. Using police data, the reduction in is an average of 206 fewer injuries per year, whereas using ED data the average reduction is only 114 fewer injuries per year. However, using police KSI data showed a reduction of 13 injuries per year, compared with a reduction of 29 injuries per year in the hospitalisation data.

DISCUSSION

The number of cyclist and pedestrian injuries captured using police-reported data was substantially lower than the ED and hospitalisation administrative data. Most notably, police-reported data only represented about 8% of all cyclist injuries presenting to the ED and 10% of the most severe injuries admitted to hospital. These estimates improved when limited to cycling MVC injuries (59% and 53% for ED visits and hospitalisations, respectively) and pedestrian injuries, but still represented only 59% and 54%, respectively, of ED visits and 53% and 48% of hospital admissions. There were substantial increases in the total number of cyclist injuries with a visit to the ED or a hospitalisation with the start of the pandemic in 2020 driven by an increase in non-MVC cycling collisions that are not generally attended to by police. Decreases were seen in ED visits due to pedestrian injuries in 2021.

Cycling injuries

Our results support previous research in in many other locations, including Vancouver, Scotland, Hong Kong, San Francisco and Queensland, Australia, which has indicated under-reporting of cycling injuries in police data.[6 12 13 22–24] However, our finding that all cycling injuries reported by the police only represented 8% of ED visits for cycling injuries is lower than most estimates. Police in Toronto are expected to respond to the most serious collisions in the city, and so may not attend and report more minor collisions or those not involving motor vehicles. Our personal communication with TPS noted that police policy regarding attending the scenes of cycling collisions changed after 2018 and is now limited to serious injuries and fatalities (personal communication, 2021). Our findings identify a

Table 2 Number of cyclist MVC and non-MVC ED visit and hospitalisations 2016–2021

Year	ED visits			Hospitalisations		
	MVC	Non-MVC	Total	MVC	Non-MVC	Total
2016	860 (16.0%)	4531 (84%)	5391	85 (19.9%)	342 (80.1%)	427
2017	753 (15.9%)	3985 (84.1%)	4738	77 (24.1%)	242 (75.9%)	319
2018	679 (15.5%)	3689 (84.5%)	4368	71 (23.3%)	234 (76.7%)	305
2019	632 (14.8%)	3629 (85.2%)	4261	63 (20.1%)	251 (79.9%)	314
2020	540 (9.00%)	5459 (91.0%)	5998	73 (14.5%)	430 (85.5%)	503
2021	554 (10.4%)	4790 (89.6%)	5344	74 (17.2%)	357 (82.8%)	431
Total	4018 (13.3%)	26083 (86.7%)	30100	443 (19.3%)	1856 (80.7%)	2299

ED, emergency department; MVC, motor vehicle collision.

Table 3 Number of police-reported pedestrian injuries compared with ED visits and hospitalisations, 2016–2020

Year	Police reported	ED visits	% Police reported versus ED visits	Police-reported killed or seriously injured	Hospitalisations	% Police reported versus hospitalisations
2016	1125	2012	55.9	175	398	44.0
2017	1019	1967	51.8	174	385	45.3
2018	1010	1830	55.2	206	352	58.5
2019	927	1736	53.4	179	345	51.9
2020	599	1118	53.6	122	274	44.5
2021	593	1098	54.0	119	262	45.4
Total	5273	9761	53.7	975	2016	48.4

ED, emergency department.

potential consequence of this change in that there was a higher representation of police-reported KSI in the hospitalisation data, as well as in the higher representation of cyclist MVC injuries.

These findings have implications for the prevention of cycling injuries if changes to the built environment and cycling infrastructure are based solely on police-reported data because it under-represents where and how many cyclists sustain injuries resulting in care in the hospital system. Although there has been some recent progress in Toronto related to the newly expanded programme of separated cycle track installations on roadways,[25] prevention of cycling non-MVC injuries may also point to more attention to changes to the built environment to prevent collisions involving, for example, street car tracks or poor roadway maintenance and off-road cycling (eg, trails and paths). Non-MVC cycling injuries may carry lower risks of severe and fatal outcomes than those involving the kinetic energy of an automobile. However, our data indicate that many non-MVC cycling injuries are severe enough to warrant hospitalisation. Of 2299 total hospital admissions from cycling injuries, 1856 (80.7%) were from non-MVC causes. Policies to prevent non-MVC cycling injuries are important from both the individual and the healthcare utilisation perspective.

Pedestrian injuries

In general, pedestrian injuries were better represented in the police-reported data for both ED visits and hospitalisations than cyclists. However, it is still worth highlighting that the best year of alignment between police-reported pedestrian injuries and the hospitalisation data was only 59% (2018), suggesting that 41% of serious pedestrian injuries would still not be included in TPS data. Further investigation is required into the mechanism of pedestrian injuries that are not being reported to police in order to determine appropriate preventive measures.

Comparison of police-reported and hospitalisations over time

The number of cyclist MVC in DAD slightly increased in 2021. Given the increased volume of cycling after the pandemic,[26 27] the decrease in the number of ED visits might be due to people avoiding the ED during this time due to fears related to transmission of COVID-19 and the overburden of the EDs due to the pandemic. Also, in 2020, the number of pedestrian injuries decreased in all three datasets and remained at lower levels in 2021.

To make the reporting process more convenient, the City of Toronto has recently implemented a series of strategies by facilitating the process of reporting by persons involved including online reporting access and a new collision reporting centre.[28] Previously the only two collision reporting centres in Toronto were located in the suburbs in Scarborough and North York,which made it difficult for many people, particularly cyclists and pedestrians to report, and was recognised as one of the underlying reasons for under-reporting of vulnerable road users.[29] It is currently unknown how effective these new centres have been in increasing the representation of cycling and pedestrian injuries.

Given that most cycling injuries are non-MVC and mostly not attended by the police, NACRS and DAD datasets can provide insights for safer design and build environment considerations, where there are environmental challenges such as streetcar tracks and uneven pavement, or on multiuse trails.[30 31] Our results suggest that non-MVC injuries have increased since the beginning of the pandemic, perhaps due to increased volumes of cyclists and an increase in new, inexperienced riders due to changes in transport mode in the response to the pandemic.[32 33]

Strengths and limitations

To our knowledge, this is the first study that provides a snapshot of the trends in cyclist and pedestrian injuries from ED and hospitalisation data compared with police-reported data for both cyclists involved in an MVC and those that were not. However, since the datasets were not linked, a detailed analysis of police data coverage of pedestrian and cyclist injuries was not possible, since we were unable to capture where differences in reporting may have been greater by age and geographical location. For example, there was evidence in an American study suggesting that child pedestrian injuries are particularly under-represented in police data.[16]

One primary limitation is that the datasets are not designed to capture the same constructs. Police-reported data only include injuries where police respond to collisions, and include Toronto residents and non-residents. The health services databases include all cyclist and pedestrian injuries, which we limited to residents of Toronto and inner suburbs treated at Toronto hospitals. Although the denominator is different, and the numbers were expected to be different, the magnitude of that difference was unexpected.

Finally, as health service utilisation data do not include the geographical location, it is not possible to assess where cyclist non-MVC injuries are occurring. Finally, while the hospital data sets included more injury events, they may not include all collisions. On-site fatalities may never show up in NACRS or DAD. However, over the time period under study, there were an average 2.5 cycling fatalities with a range from 1 to 4 so even if none of them were included in the health service data the results would change only slightly. Further, some non-hospitalised injuries may be treated in locations which are not included in NACRS. The nature of Ontario data, however, makes us

confident that we accurately captured all hospitalisations from these injury mechanisms.

CONCLUSIONS

This analysis of cyclist and pedestrian injuries from three different databases highlights the need for a more comprehensive comparison of these data sources through data linkage. Relying on police-reported data alone can lead to inaccurate evaluation of injuries both in terms of burden and changes over time. The AHRQ process through ICES has facilitated the acquisition of timely health services data for cities in Ontario that can be used for future transportation planning, However, the opportunity to link these data with police-reported data would be invaluable to allow a better understanding of who is missed by police data and assess the variability by age and location of injury. This information could be used by municipalities when planning changes to the built environment to make it safer for pedestrians and cyclists. It would also allow them to understand the magnitude of injuries not involving a motor vehicle.

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Contributors AKM and LR designed the study. BZ and RS completed data extraction and analysis. AWH, MAH and SN provided inpute into the study design. All authors provided critical analysis of the manuscript. AKM is acting as the guarantor of this study.

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Competing interests None declared.

Patient and public involvement Patients and/or the public were involved in the design, or conduct, or reporting, or dissemination plans of this research. Refer to the Methods section for further details.

Patient consent for publication Not applicable.

Ethics approval The use of the data in this project is authorised under section 45 of Ontario's Personal Health Information Protection Act (PHIPA) and does not require review by a research ethics board.

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Data availability statement Data are available upon reasonable request. Aggregate police data are available in an open-access repository, and aggregate health services data are available to researchers and other stakeholders on request.

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