How accurate is the identification of serious traffic injuries by Police? The concordance between Police and hospital reported traffic injuries

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Abstract

Police reported crash data are the primary source of crash information in most jurisdictions. However, the definition of serious injury within police-reported data is not consistent across jurisdictions and may not be accurate. With the Australian National Road Safety Strategy targeting the reduction of serious injuries, there is a greater need to assess the accuracy of the methods used to identify these injuries. A possible source of more accurate information relating to injury severity is hospital data. While other studies have compared police and hospital data to highlight the under-reporting in police-reported data, little attention has been given to the accuracy of the methods used by police to identify serious injuries. The current study aimed to assess how accurate the identification of serious injuries is in police-reported crash data, by comparing the profiles of transport-related injuries in the Queensland Road Crash Database with an aligned sample of data from the Queensland Hospital Admitted Patients Data Collection. Results showed that, while a similar number of traffic injuries were recorded in both data sets, the profile of these injuries was different based on gender, age, location, and road user. The results suggest that the 'hospitalisation' severity category used by police may not reflect true hospitalisations in all cases. Further, it highlights the wide variety of severity levels within hospitalised cases that are not captured by the current police-reported definitions. While a data linkage study is required to confirm these results, they highlight that a reliance on police-reported serious traffic injury data alone could result in inaccurate estimates of the impact and cost of crashes and lead to a misallocation of valuable resources.

Introduction

Police reported crash data are the primary source of crash information in most jurisdictions. However, the definition of serious injury within police-reported data is not consistent across jurisdictions and may not be accurate. With the Australian National Road Safety Strategy (ATC, 2011) targeting the reduction of serious injuries, which was not previously the case, there is a greater need to assess the accuracy of the methods used to identify these injuries. Accurate severity information is important for prioritisation of intervention locations, understanding transport-related incident mechanisms, evaluating the effectiveness of interventions or countermeasures, and the calculation of the cost of crashes. In most Australian jurisdictions, the current classification of severity, and ultimately serious injury, by police is primarily based on process rather than a clinical assessment per se. Injury severity (with the exception of a fatality) is classified based on the extent of medical intervention (i.e., requiring medical treatment, taken or admitted to hospital). In Queensland, this classification is as follows: fatality; hospitalisation (taken to hospital); medical treatment; minor injury; and property damage only. Studies in other jurisdictions (e.g., New Zealand, USA) have shown that categories like these do not always correspond with objective measures relating to threat to life. Fatal cases and those with an absence of injury are generally accurately classified; however, the non-fatal injuries are more likely to be misclassified based on more objective severity measures (Farmer, 2003; McDonald, Davie, & Langley, 2009).

Arguably, it would be more accurate if the severity of an injury was based on clinical information (i.e., the nature of the injury) and involved some sort of assessment of threat to life or permanent disability. However, collecting this clinical information at the roadside particularly by police may not be ideal. Police do not have the training or expertise to record information on the nature of an injury or injuries with the required level of accuracy. Also, the consistency of the recorded information from case to case could be questionable (Ward, Lyons, Gabbe, Thoreau, Pinder, & Macey, 2010).

A possible source of more accurate information relating to injury severity is hospital data. While other studies have compared police and hospital data to highlight the under-reporting in police-reported data, little attention has been given to the accuracy of the methods used by police to identify serious injuries. The current study aimed to, in addition to highlighting the possible under-reporting of crashes to police, assess how accurate the identification of serious injuries is in police-reported crash data. It aimed to do this by comparing the profiles of traffic-related (hospitalised) injuries in the Queensland Road Crash Database and identified traffic-related injuries in the Queensland Hospital Admitted Patients Data Collection.

Methods

Ethics approval was obtained from the Queensland University of Technology's Human Research Ethics Committee (#1100001065). A Public Health Act agreement was completed by the researcher and signed by Queensland Health. The Queensland Road Crash Database (QRCD) data was provided following approval (via designated form) from the Manager of the Data Analysis Unit at the Department of Transport and Main Roads. Queensland Hospital Admitted Patients Data Collection (QHAPDC) data was provided by the Manager of the Health Statistics Centre at Queensland Health.

Data sources

Queensland Road Crash Database (QRCD)

The QRCD stores information relating to all police reported crashes in Queensland since 1986. The definition of a police reported crash is:

> "a crash that has been reported to the police which resulted from the movement of at least one road vehicle on a road and involving death or injury to any person, or property damage to the value of:
>
> - $2500 to property other than vehicles (after 1 December 1999)
> - $2500 damage to vehicle and property (after 1 December 1991 and prior to 1 December 1999)
> - value of property damage is greater than $1000 (prior to December 1991) or;
> - at least one vehicle was towed away." Department of Transport and Main Roads (2010)

A crash will be excluded from the database, even if it complies with the above definition, if the incident involved deliberate intent (e.g., assault, suicide) or is not attributable to vehicle movement.

Queensland Hospital Admitted Patient Data Collection (QHAPDC)

QHAPDC contains data on all patients separated (an inclusive term meaning discharged, died, transferred or statistically separated) from any hospital permitted to admit patients, including public psychiatric hospitals.

Data specifications

Cases for each data collection were selected based on their alignment with the Queensland Road Crash Data definition of a traffic-related injury (i.e., occurred on a public road and involved a moving vehicle). Where possible, other exclusions based on the definition outlined in Queensland Road Crash Data were also applied (e.g., intentional acts, pedestrian colliding with a railway train). In order to conduct analyses, the following variables were used for each data set:

Age was coded into 5 year age groups (with the exception 85+).

Gender (1 = Male; 2 = Female). Some data sets refer to sex rather than gender, however, gender will be the term used throughout.

Severity of injury was measured by three variables: *Broad severity*, *Abbreviated Injury Scale*, *and Survival Risk Ratios*.

1. *Broad severity* was coded into three levels (fatality; hospitalisation; other injury). These categories are the basis for how severity is generally captured across jurisdictions. It should be noted that for the purposes of this categorisation, hospitalisation will be treated as 'taken to hospital' as defined by the QRCD.
2. *The Abbreviated Injury Scale (AIS)* is a body-region based coding system developed by the Association for the Advancement of Automotive Medicine (AAAM, 2008). A single injury is classified on a scale from 1-6 (1 = minor; 2 = moderate; 3 = serious; 4 = severe; 5 = critical; and 6 = maximum). If there is not enough information to assign a value, a code of 9 (not specified) is applied. For the purposes of this study, the AIS score was mapped to principle diagnosis International Classification of Diseases (ICD-10-AM) codes in the data (NCCH, 2008). A tool for mapping ICD codes to AIS score was sourced from the European Center for Injury Prevention.
3. *Survival Risk Ratios (SRR)*, assigned to a single injury, provide an estimate of the probability of death and is based on ICD-10-AM coding, ranging from 0 (no chance of survival) to 1 (100% chance of survival). SRRs were mapped to principle diagnosis ICD codes as used by Stephenson, Henley, Harrison, and Langley (2003). It should be noted that it was not possible to calculate ICISS (ICD Injury Severity Score), which a more comprehensive assessment of injury severity than SRR alone. This was because, to calculate ICISS information on all the injuries a patient suffers requires the calculation of the multiplication of SRRs for each injury and each data set only provided the principle diagnosis.

In order to specifically explore issues of serious injury definitions, three classifications of *serious injuries* were derived:

1. SRRs equal to or less than 0.941 were coded as serious with all other values coded as non-serious. This criterion was based on the work of Cryer and Langely (2006).
2. All those with an AIS of 3 or greater were classified as serious, the rest as non-serious.
3. All those coded as hospitalised and fatal were classified as serious, the rest as non-serious.

Accessibility/Remoteness Index of Australia (ARIA+) broadly classifies geographic areas based on their distance from the five nearest major population centres (National Centre for Social Applications of GIS, 2009). ARIA+ is categorised into five groups (1 = Major Cities;

2 = Inner Regional; 3 = Outer Regional; 4 = Remote; 5 = Very Remote). Some of the data sets included ARIA+ classifications, while others provided postcode. In cases where postcode was provided without ARIA+, postcodes were mapped to ARIA+ using data from the Australian Bureau of Statistics. Some postcodes map to multiple ARIA+ categories, so in these cases the postcode is assigned to the ARIA+ category that has the largest proportion of the population.

Road user was coded into five categories (1 = Driver, 2 = Motorcyclist (including pillions), 3 = Cyclist (including pillions), 4 = Pedestrian; 5 = Passenger).

Queensland Road Crash Database (QRCD)

By definition, all injury cases in the QRCD for 2009 were included. However, for the purposes of comparison with QHAPDC, only fatalities and hospitalisations were used.

The coding of variables was as follows:

Age was provided in years, and was coded into 5 year age groups (with the exception of 85+).

Gender was retained as coded (1 = Female; 2 = Male).

Broad severity was coded from the variable *casualty severity* (1= fatality; 2 = hospitalisation; 3 = medical treatment; 4 = minor injury), with 'medical treatment' and 'minor injury' collapsed into the 'other injury' category.

AIS and *SRR*, was coded using the *injury description* variable. This variable, while a text description, is recorded in a standard form that is the same as those of the ICD-10-AM principle diagnosis descriptions. This allowed a principle diagnosis ICD-10-AM code to be mapped to each injury description. These ICD codes were then mapped to the AIS and a SRR using processes outlined previously.

ARIA+ was an already coded variable in the data, so was retained in its original form. *ARIA+* in this case relates to the location of the crash.

Road user was categorised using the variable *casualty road user type*. The original variable coding was retained from this variable with the exception of 'motorcycle pillions' and 'bicycle pillions'. These two classifications were put into the 'motorcyclist' and 'cyclist' categories respectively.

Queensland Hospital Admitted Patient Data Collection (QHAPDC)

To select traffic-related injuries for 2009 for comparison to QRCD, the first step involved selecting cases that were coded as being land transport-related. For the QHAPDC collection this included cases with an ICD-10-AM external cause code from V00-V89. Using the fourth character in the ICD-10-AM external cause code to identify whether an incident was traffic or non-traffic, 43,991 (67.8%) of land transport cases were classified as traffic. Other exclusions were also made due to cases not fitting the definition of a road crash. Specifically, when the injury resulted from a pedestrian colliding with a pedestrian conveyance (V00) or a railway train (V05) it was not included. Also, all transfers, as identified by *separation mode* were excluded to partly eliminate multiple counts of cases.

Variables were selected, created and/or recoded as follows:

Age was provided in 5 year age groups (with the exception of 85+).

Gender was retained as coded (1 = Female; 2 = Male).

Broad severity was defined using the *mode of separation* variable, with those coded as 'died in hospital' categorised as a fatality and all other cases categorised as 'hospitalised'.

AIS and *SRR*, was coded using the principle diagnosis ICD-10-AM codes. These ICD codes were then mapped to the AIS and a SRR using processes outlined previously.

ARIA+ was an already coded variable in the data, so was retained in its original form. *ARIA+* in this case relates to the location of the hospital.

Road user was categorised using the second and fourth characters of the ICD-10-AM external cause code.

Data analysis

Data was imported from csv into SPSS 19 for coding and analysis. Comparisons were made using Chi-square tests of independence. Due to the large sample size, a more stringent alpha of .001 was adopted. Also, Cramer's V (ϕ_c) was calculated in order to provide an estimate of effect size to give a clearer idea of the meaningfulness of any statistical significance found. As suggested by Aron and Aron (1991), a Cramer's V of less than .10 was considered to be a small effect size, between .10 and .30 moderate, and more than .30 a large effect size. Post-hoc analyses were also undertaken using an adjusted standardised residual statistic. This statistic can be used to identify those cells with observed frequencies significantly higher or lower than expected. With an alpha level set at .001, adjusted standard residuals outside -3.10 and +3.10 were considered significant (Haberman, 1978).

Results

Overall, in 2009, QHAPDC had 6,725 compared to 7,003 cases in QRCD. In terms of the profile of cases, compared to the QRCD, the QHAPDC had a statistically significantly greater proportion of males, motorcyclists, and cyclists included in the data collection. QHAPDC also had a higher proportion of younger people (14 and younger) [$\chi^2(17) = 125.69$, $p < .001$, $\phi_c = .10$] and a lower proportion of cases in remote or very remote areas compared to QRCD (see Figure 1 and Table 1).

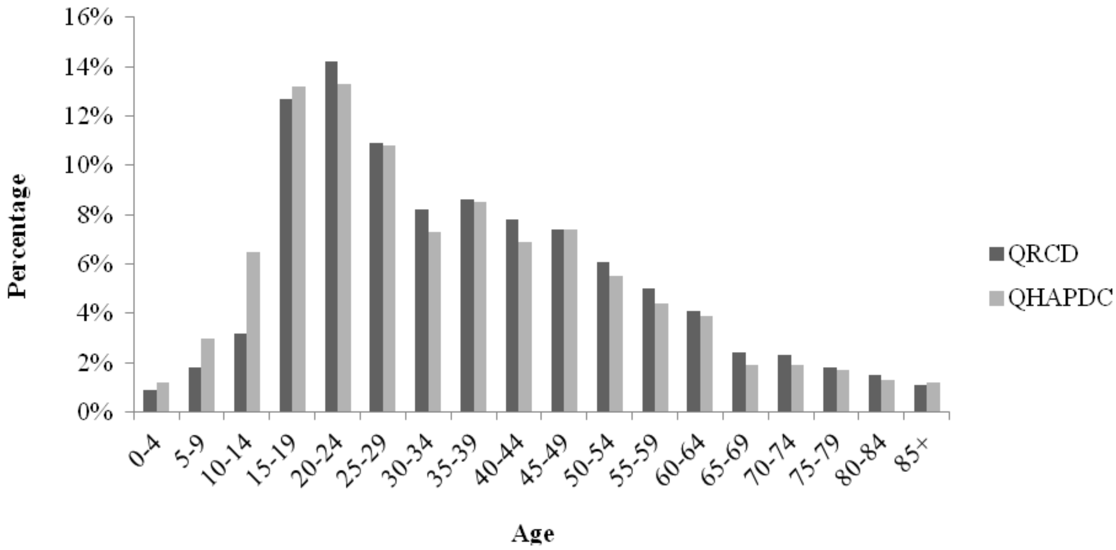

Figure 1. Age distribution of QRCD and QHAPDC for 2009

Table 1. Demographic characteristics by data source for QRCD and QHAPDC 2009

Variable	Level	Data source		Significance test
		QRCD n (%)	QHAPDC n (%)	
Gender	**Male**	4,039 (57.7)	4,646 (69.1)[1]	
	Female	2,960 (42.3)	2,079 (30.9)	$\chi^2(1) = 191.06, p < .001, \phi_c = .12$
ARIA+	**Major Cities**	3,611 (51.6)	3,753 (55.8)	
	Inner Regional	1,644 (23.5)	1,745 (25.9)	
	Outer Regional	1,320 (18.9)	1,063 (15.8)	
	Remote	246 (3.5)	116 (1.7)[1]	
	Very Remote	181 (2.6)	48 (0.7)[1]	$\chi^2(4) = 151.87, p < .001, \phi_c = .11$
Road user	**Driver**	3,723 (53.2)	1,904 (29.5)	
	Motorcyclist	1,015 (14.5)[1]	2,024 (31.4)[1]	
	Cyclist	362 (5.2)[1]	1,067 (16.5)[1]	
	Pedestrian	464 (6.6)	435 (6.7)	
	Passenger	1,439 (20.5)	1,021 (15.8)	$\chi^2(4) = 162.62, p < .001, \phi_c = .11$

[1] Standardised residuals outside +/- 3.10

In terms of broad severity, not surprisingly, QRCD had a greater proportion of fatalities compared to QHAPDC. Based on AIS, QHAPDC had greater proportion of moderate injuries; however, there was no difference on SRR in terms of the proportion of serious vs. non-serious (see Table 2). However, it should be noted that much greater proportion of the QRCD were unable to be classified, due to the missing injury description data, for either AIS or SRR compared to QHAPDC.

Table 2. Severity profile by data source for QRCD and QHAPDC 2009

Variable	Level	Data source		Significance test
		QRCD n (%)	QHAPDC n (%)	
Broad severity	**Fatality**	331 (4.7) [1]	71 (1.1)[1]	
	Hospitalisation	6,672 (95.3)	6,654 (98.9)	$\chi^2(1) = 162.62, p < .001, \phi_c = .11$
Unspecified injury	**Yes**	5,602 (86.5)[1]	31 (0.5) [1]	
	No	1,401 (19.3)	6,694 (99.5)	$\chi^2(1) = 8968.61, p < .001, \phi_c = .81$
AIS	**Minor**	633 (45.2)	2,037 (34.8)	
	Moderate	424 (30.3)	2,789 (47.7)[1]	
	Serious	342 (24.4)	900 (15.4)	
	Severe	0 (0.0)	89 (1.5)	
	Critical	1 (0.1)	21 (0.4)	
	Maximum	1 (0.1)	16 (0.3)	$\chi^2(5) = 190.46, p < .001, \phi_c = .16$
SRR	**Serious (< 0.942)**	177 (12.7)	921 (13.8)	
	Non-serious (> 0.941)	1,218 (87.3)	5,733 (86.2)	$\chi^2(1) = 1.13, p = .288, \phi_c = .01$

[1] Standardised residuals outside +/- 3.10

Due to the substantial amount of missing and unspecified data (injury description) in QRCD which was used to calculate AIS and SRR, an analysis was conducted to see if there was any bias based on the broad severity measure. It should be noted that this was conducted on all 2009 cases, including the other injury category.

There was a statistically significant difference in the proportion of unspecified injury descriptions by broad severity [$\chi^2(2) = 1036.9$, $p < .001$, $\phi_c = .23$]. Specifically, the injury description was more likely than expected to be unspecified for hospitalisations and less likely than expected to be unspecified for fatalities (see Table 3).

Table 3. Unspecified injury description by broad severity for QRCD 2009

	Injury description	
	Specified n (%)	**Unspecified** n (%)
Fatality	300 (90.6)	31 (9.4)[1]
Hospitalisation	1,101 (16.5)[1]	5,571 (83.5)[1]
Other injury	2,755 (22.9)	9,260 (77.1)

[1] Standardised residuals outside +/- 3.10

Table 4 shows the proportion of serious injuries in QRCD based on Broad Severity, AIS, and SRR classification criteria. There were a much larger proportion of serious injuries classified when using the broad severity criteria compared to both AIS and SRR. A total of 38 cases were classified as serious using all three criteria. While the SRR and AIS proportions are quite similar, interestingly, only 40 cases were coded as serious under both AIS and SRR criteria.

Table 4. The number and proportion of serious and non-serious injuries based on the three different severity measure criteria, QRCD 2009

	Broad severity (Fatal and Hospitalised)	**AIS (score of 3 or above)**	**SRR (0.941 or less)**
Serious	7,003 (36.8%)	355 (8.6%)	387 (9.3%)
Non-serious	12,015 (63.2%)	3,788 (91.4%)	3,762 (90.7%)

Table 5 shows the proportion of serious injuries in QHAPDC based on Broad Severity, AIS, and SRR classification criteria. Due to the nature of the data collection (all cases hospitalised or fatality), based on broad severity, all cases are classified as serious. The proportion of serious cases based on AIS was higher than the proportion of serious based on SRR. There were 488 cases coded as serious under both AIS and SRR criteria.

Table 5. The number and proportion of serious and non-serious injuries based on the three different severity measure criteria, QHAPDC 2009

	Broad severity (Fatal and Hospitalised)	**AIS (score of 3 or above)**	**SRR (0.941 or less)**
Serious	6,725 (100.0%)	1,026 (17.5%)	921 (13.8%)
Non-serious	0 (100.0%)	4,826 (82.5%)	5,773 (86.2%)

To further explore the broad severity classification, the median of SRRs were calculated for each broad severity category for each data collection. Table 6 shows, for QRCD, that the median SRR was lowest (more severe) for fatalities. Surprisingly, the median SRR for other injury was lower than that of hospitalisations, suggesting that other injuries (medical treatment and minor injuries) are more severe than those cases taken to hospital. This table also shows that the range of severities (as measured by SRR) was quite wide within each broad severity category.

Table 6. Median and range SRR for each broad severity category, QRCD 2009

	Median SRR	**Range (min – max)**
Fatality	0.940	0.746 – 1.000
Hospitalisation	0.985	0.500 – 1.000
Other injury	0.954	0.554 – 1.000

Table 7 shows, for QHAPDC, that the median SRR was lower (more severe) for fatalities compared to hospitalised cases. The range of severities (as measured by SRR) was quite wide for both fatalities and hospitalisations.

Table 7. Median and range SRR for each broad severity category, QHAPDC 2009

	Median SRR	**Range (min – max)**
Fatality	0.867	0.306 – 0.996
Hospitalisation	0.991	0.306 – 1.000

Discussion

In terms of overall numbers, the difference between QRCD and QHAPDC was minimal. However, when the profiles were compared, there were significant differences between QRCD and QHAPDC. Specifically, QHAPDC had a greater proportion of males, younger people (aged 0-14), motorcyclists, and cyclists compared to QRCD. These differences provide some evidence of under-reporting for QRCD and that this under-reporting has a bias towards certain injured persons. This under-reporting, specifically including these motorcyclists and cyclists, has been demonstrated in other research in the area (Alsop & Langley, 2001; Cryer et al., 2001; Langley, Dow, Stephenson & Kypri, 2003).

However, it is also possible that some of the differences are not due to under-reporting, but instead due to misclassification of traffic-related injuries in QHAPDC and/or the lack of precision in the technique for selecting traffic injury cases. It is not clear at this stage how valid QHAPDC coding is in terms of identifying traffic cases and road users. The primary purpose of this data is not for this type of classification, so it is possible that the accuracy of the coding could be compromised. It is also possible that the classification of hospitalised in QRCD is also incorrect. Further research, using data linkage, may quantify the extent of misclassification versus under-reporting.

In addition to the above differences, QHAPDC had a lower proportion of Remote and Very Remote cases based on ARIA+ compared to QRCD. This result is perhaps not surprising considering the classification basis for each collection. QHAPDC ARIA+ relates to the location of the hospital, whereas QRCD ARIA+ relates to the location of the crash. It is likely that even when a crash occurs in a Remote or Very Remote location, the injured person would not necessarily be treated in a hospital in a Remote or Very Remote location due to lack of facilities. Also, excluding transfer cases would select out many cases from facilities in Remote and Very Remote locations, as the patient would likely be transferred to a facility in a less remote location. Ultimately, these differences would bias this comparison somewhat. This bias may have been reduced by selecting out the transfers from the final hospital not the initial hospital (using *Admission Source*). However, this technique can introduce other issues with completeness and reliability and was also not available to the researcher for this study.

For severity, there was no difference between the collections in terms of the proportion classified as serious based on Survival Risk Ratio (SRR). However, QRCD had a greater proportion of fatalities and serious or worse AIS classification compared to QHAPDC. The difference between the collections in terms of fatalities is not surprising as there would be a considerable number of fatalities that are not admitted to hospital (i.e., died at scene, died in transit, and died on arrival). Generally, the differences in severity between QRCD and QHAPDC should be treated with caution. QRCD had a considerably greater proportion (87% vs. 0.5%) of missing/unspecified injury descriptions which were used to determine AIS and SRR. There was also a bias in the amount of missing and unspecified injury descriptions in QRCD in terms of broad severity. Specifically, it was found that the injury description was less likely to have complete information when the case was hospitalised. It is possible that police may be less likely to complete the injury description field in cases where other parties (e.g., ambulance officers or hospital staff) are involved (as would be the case with a hospitalised case), as the police officer would defer to medical staff expertise and may think they would better capture that information in other data sources. It is also possible that in cases where the injured person is taken to hospital, that the police officer may not have the opportunity to assess the injury due the person being treated at the time or having already left the scene by the time the officer arrives. The incompleteness and inconsistency of the information required for determining objective severity measures provides further evidence that using police data alone for determining severity is problematic.

For both data collections, the ranges of severity values were quite varied. The AIS, SRR, and broad severity classification of serious injury do not correspond. It appears that using police data with a measure relating to be taken to hospital may not be indicative of serious injury. There is a broad range of injury types and SRRs within this category, and the category of ‘other injuries’ actually had a lower median SRR (more severe) than the hospitalised category. However, even based on a definition that is restricted to those admitted to hospital (as is the case in QHAPDC) it still may not be specific enough, as the range of SRRs within this category was quite wide.

Conclusion

Both the possible under-reporting in combination with the lack of precision with assigning severity found in this study make it difficult to accurately determine the cost and impact of serious injury crashes. A more precise measure of serious injury would be preferred over current practice as it is more closely related to threat to life and therefore more directly corresponding to the outcomes being measured when cost and impact is determined. Unfortunately, due to the large amount of missing information in police data, and the questionable accuracy of what is there, relying on police data alone to determine the prevalence and nature of serious injury crashes could be misleading. The inclusion of other data sources, such as hospital data, in the determination of serious injury crash impact has the potential to address the shortcomings of current approaches. However, these data collections often lack other information, which is included in police data, which are needed to determine the nature and circumstances of crashes (e.g., alcohol involvement, speed). As a result, data linkage (combining the data collections when they have individuals in common) is increasingly becoming a popular alternative to using individual data collections. Further research is required however, to assess the possibilities of data linkage, including its feasibility in the context of road safety.

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