2018

Clinically serious injured (MAIS 3+) road casualties in Northern Ireland, 1999-2016

Summary

This is the second report in this series, and presents the 2016 update. The MAIS 3+ data included in this report are produced using casualty admissions to hospitals in Northern Ireland, between 1999 and 2016, with a clinically defined serious injury following a road traffic collision. The data show that the series peaked in 2002 with 235 serious injury (SI) casualties, after which numbers began to fall. The most recent five years have shown evidence that the historic downward trend may now be levelling off. In the latest available year, 2016, there were 68 MAIS 3+ casualties – this is a decrease of 71% since the peak in 2002, and a decrease of 15% since last year. While the numbers of MAIS 3+ serious injuries is much lower than reported by the PSNI, the overall trends are similar: both series have shown an historic decrease followed by signs of levelling off over the latest few years.

Overall, 8% of hospital admissions in the last five years have injuries classified as MAIS 3+; however, the proportion differs by road user type, with motorcyclists having the greatest proportion of admissions that were MAIS 3+ (10%) and pedal cyclists the smallest (7%).

Comparing the number of hospital admissions to police reported serious injuries we see that a significant proportion (around 30%) of SI casualties is not known to the police. This under-reporting issue has been noted across many jurisdictions including GB and RoI.

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In this Research Paper

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Clinically seriously injured (MAIS 3+) road casualties in Northern Ireland, 1999-2016

The Abbreviated Injury Scale (AIS) is a clinical measure used to classify and describe the severity of injuries; it represents the threat to life associated with the injury. A score of 1 indicates a minor injury, while 6 refers to an unsurvivable injury. A casualty that sustains an injury with a score of 3 or higher on the AIS is classified as clinically seriously injured (MAIS 3+).

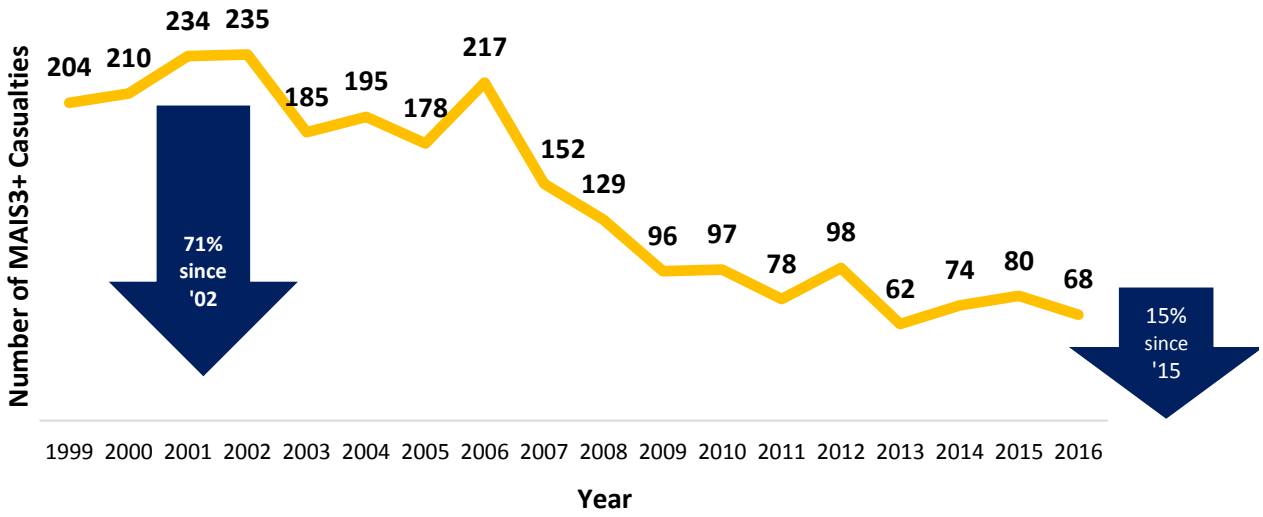
AIS-code	Injury	Example
1	Minor	Superficial laceration
2	Moderate	Fractured sternum
3	Serious	Open fracture of humerus
4	Severe	Perforated trachea
5	Critical	Ruptured liver
6	Unsurvivable	Total severance of aorta
9	Not known	

The MAIS 3+ data presented in this report are produced using casualty admissions to hospitals in Northern Ireland, between 1999 and 2016, with a clinically defined serious injury following a road traffic collision. See methodology on page 12 for further detail.

Note that the MAIS 3+ definition of a serious injury is set at a much higher threshold than the current PSNI definition which classes any hospital inpatient admission resulting from a traffic collision, irrespective of the nature of the injuries sustained by the casualty, as a serious injury.

MAIS 3+ in Northern Ireland

Chart 1: MAIS 3+ road casualties in Northern Ireland, 1999-2016

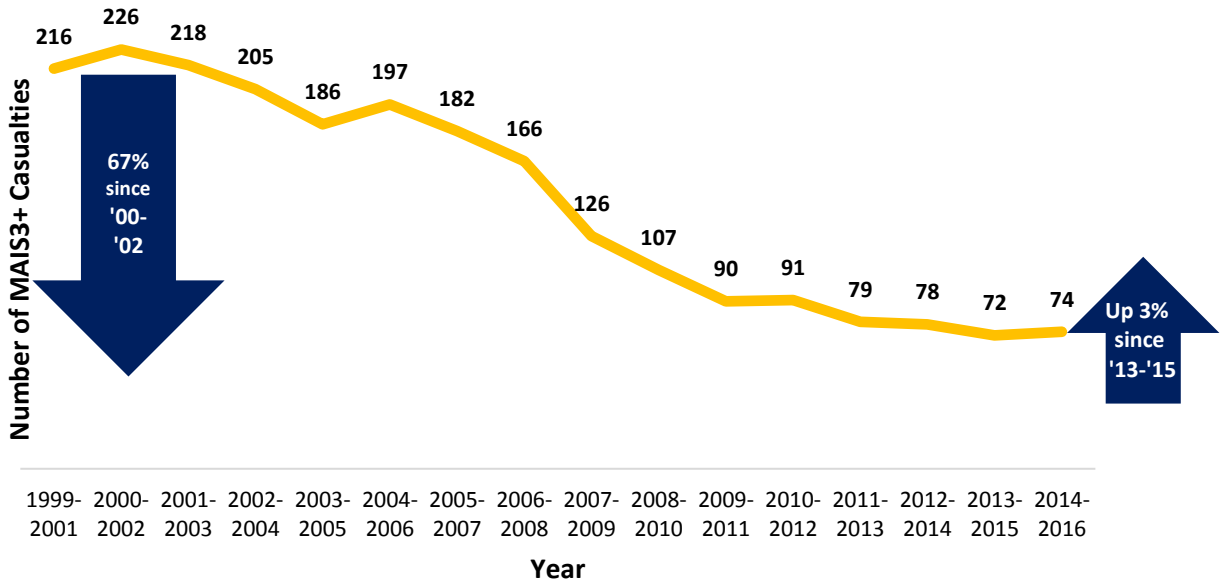


NB: A single patient may have more than one admission of care arising from a single collision; however, the number of such cases is expected to be very small.

Chart 1 above shows the number of clinically seriously injured (MAIS 3+) road casualties in Northern Ireland from 1999 to 2016. The series peaked in 2002 with 235 serious injury (SI) casualties, after which numbers began to fall (with a temporary rise in 2006). Looking at only the most recent five years, there is evidence that the historic downward trend may now be levelling off; during this period there was a peak of 98 clinical SIs in 2012, followed by a sharp decrease of over one-third (37%) to 62

in 2013, the series low. In the latest available year, 2016, there were 68 MAIS 3+ casualties – this is a decrease of 71% since the peak in 2002, and a decrease of 15% since last year.
There has been considerable variability year-on-year across the period, although this is to be expected given the relatively small number of admissions in NI that meet the higher MAIS 3+ severity threshold. For this reason, the smoothed trend is presented below.

Chart 2: MAIS 3+ road casualties in Northern Ireland, 1999-2016 (3-Year Rolling Average)



The rolling average in Chart 2 shows more clearly the downward trend. In the time frame examined, the SIs reached their highest level in the period 2000-02 (average SIs = 226), after which the numbers started to fall. The temporary rise in 2006 is, however, still evident. The latest 3 years, 2014-16 had an average number of 74 SIs, a reduction of over two-thirds (67%) on the series peak; however, the figure is up 3% since 2013-2015. The smoothed trend, which showed large reductions earlier in the series, began to show a much reduced rate of reduction around the beginning of the current decade; the most recent data would indicate that the rate has levelled off and begun to increase. It will be interesting to see whether this further increases in future years as younger drivers continue to return to our roads.

What is the need for MAIS 3+?

The current reporting of serious injuries is derived from PSNI data. It is based on the judgement of the reporting police officer, following defined guidelines, rather than on medical expertise. The main limitation is the extent to which PSNI data represents the true level of collisions that occur; research carried out suggests that a considerable proportion of non-fatal casualties in GB (and by extension in NI) are not known to the police. The PSNI data are directly comparable with GB and ROI but are not generally considered comparable with other international jurisdictions due to significant differences in the grading of severity of injury which can be applied. Reporting serious injury casualties using MAIS 3+ will therefore provide a more accurate, clinical definition of serious injury, while simultaneously correcting for the underreporting of police data and international definitional differences. It is the definition of road traffic serious injury currently recommended by the EU but, it should be stressed again, is at a much higher severity threshold than the existing PSNI/Stats19 definition.

MAIS 3+ compared with police-reported data

Table 1: Admissions to hospital for road traffic collisions and PSNI reported Serious Injuries, 1999-2016 (Northern Ireland)

Year of admission	Number of admissions*	MAIS3+	MAIS3+/ Admissions	PSNI Serious Injuries	MAIS3+ /PSNI SIs	PSNI SIs/ Admissions
1999	2,429	204	8%	1,509	14%	62%
2000	2,409	210	9%	1,786	12%	74%
2001	2,405	234	10%	1,682	14%	70%
2002	2,290	235	10%	1,526	15%	67%
2003	1,865	185	10%	1,288	14%	69%
2004	1,833	195	11%	1,183	16%	65%
2005	1,695	178	11%	1,073	17%	63%
2006	1,751	217	12%	1,211	18%	69%
2007	1,687	152	9%	1,097	14%	65%
2008	1,404	129	9%	990	13%	71%
2009	1,355	96	7%	1,035	9%	76%
2010	1,130	97	9%	892	11%	79%
2011	978	78	8%	825	9%	84%
2012	1,030	98	10%	795	12%	77%
2013	1,026	62	6%	720	9%	70%
2014	989	74	7%	710	10%	72%
2015	986	80	8%	711	11%	72%
2016	917	68	7%	828	8%	90%
1999-2016	**28,179**	**2,592**	**9%**	**19,861**	**13%**	**70%**

* A single patient may have more than one admission of care arising from a single collision; however, the number of such cases is expected to be very small.

Of the 28,179 hospital admissions in NI for road traffic collisions between 1999 and 2016, only 2,592 (9%) were considered to be seriously injured based on the MAIS 3+ definition. It should be noted that the MAIS score was unknown in 15% of cases, so the true number of admissions with a MAIS 3+ may be significantly higher. See table 1 above.

The number of MAIS 3+ casualties in NI is much lower than the number of seriously injured casualties reported by PSNI; over the 18 year period 1999-2016, the numbers of MAIS 3+ casualties accounted for 13% of PSNI serious injuries (see table 1). This reflects the higher severity threshold for a serious injury on the MAIS scale offset, to a certain extent, by the PSNI under-reporting issue.

In general, PSNI defines a serious injury[1] as one for which a person is detained in hospital as an 'in-patient' or if they have one or more injuries from a predefined list. The 18 year total for PSNI SIs was 19,861, and by contrast, the 18 year total for admissions to hospital for road traffic collisions was 28,179. This highlights the fact (mentioned previously) that there is a significant proportion (around 30%) of SI casualties not known to the police. This under-reporting issue has been noted across many jurisdictions including GB and RoI. The most recent year has shown the highest levels of reporting – with PSNI SIs accounting for 90% of hospital admissions; the previous series high was 84% in 2011. It is

[1] Full PSNI definition of serious injury: an injury for which a person is detained in hospital as an 'in-patient', or any of the following injuries whether or not the person is detained in hospital: fractures, concussion, internal injuries, crushing's, burns, severe cuts and lacerations or severe general shock requiring medical treatment.

unclear why the proportion this year is higher, and it will be interesting to see whether future years maintain this level.

Chart 3: MAIS 3+ casualties following a road traffic collision and PSNI reported Serious Injuries, 1999 -2016 (Northern Ireland)

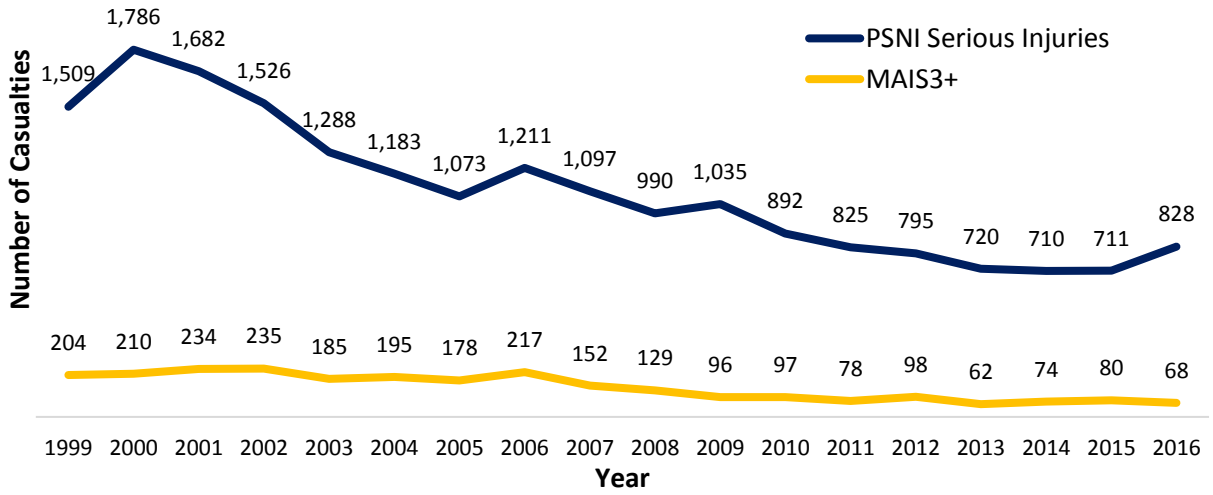
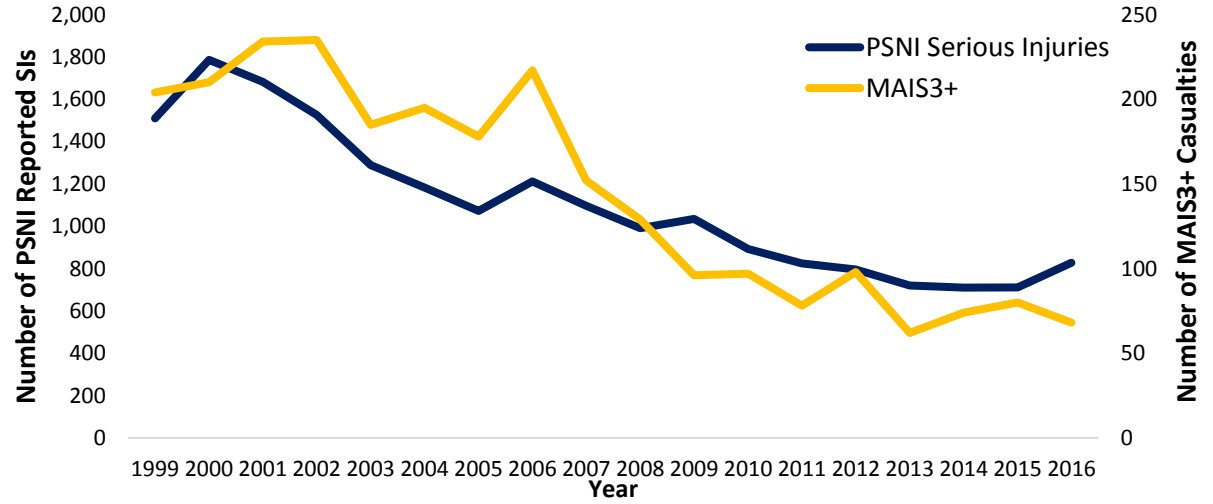


Chart 4: MAIS 3+ casualties following a road traffic collision and PSNI reported Serious Injuries, 1999 -2016 (Alternate Version) (Northern Ireland)

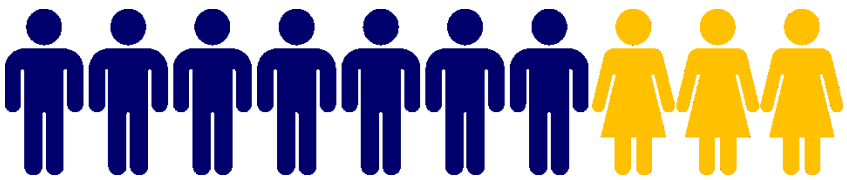


Charts 3 and 4 show the PSNI SIs and MAIS 3+ casualty numbers; in chart 4, the overall trends can be better compared. Notwithstanding the difference in the levels of SIs reported on both definitions, it is noteworthy that both series have shown an historic decrease followed by signs of levelling off in recent years. The large peak seen in MAIS 3+ casualties in 2006 was echoed in the PSNI data; however, the greater variability associated with the much smaller numbers of MAIS 3+ casualties mean its peak is more pronounced.

In 2016, there appears to be disparity in the two trends – PNSI SIs have increased while MAIS3+ casualties (and overall hospital admissions for road traffic collisions) have decreased. This is not an unknown occurrence, with similar inconsistencies apparent in 2001, 2004, 2009 and 2012. It will be interesting to see how both trends continue to track each other in the future.

Analysis of MAIS 3+ casualties

Gender

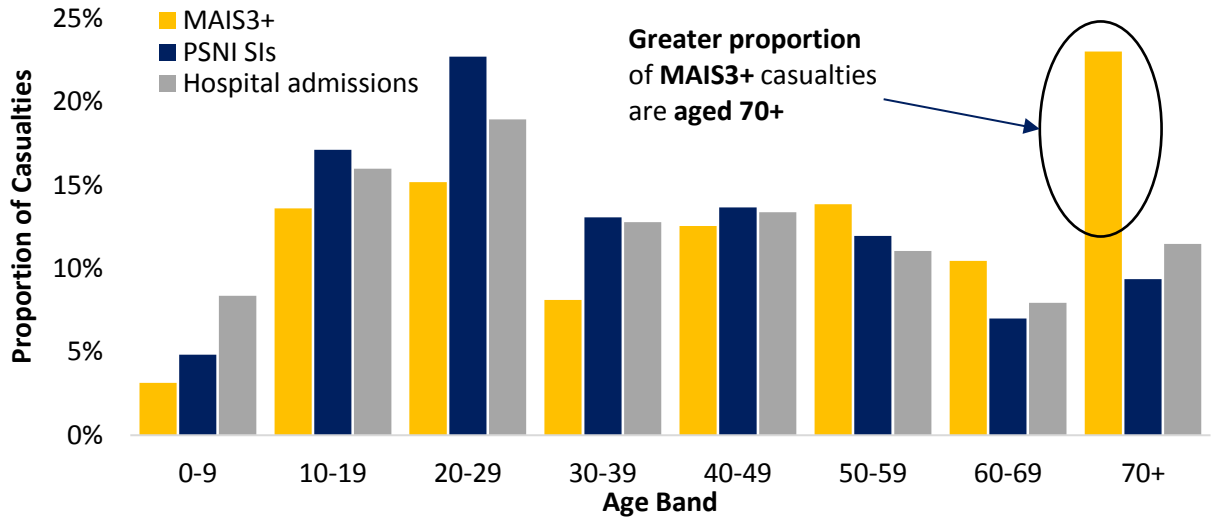


7 in 10 MAIS 3+ casualties are **male**

Males accounted for just over seven-tenths (71%) of the total MAIS 3+ casualties in Northern Ireland in the five years from 2012 to 2016. This is greater than the proportions for overall hospital admissions and PSNI serious injuries (with both series reporting 65% of casualties were male).

Age

Chart 5: MAIS 3+ casualties by age[2], 2012-2016 (Northern Ireland)



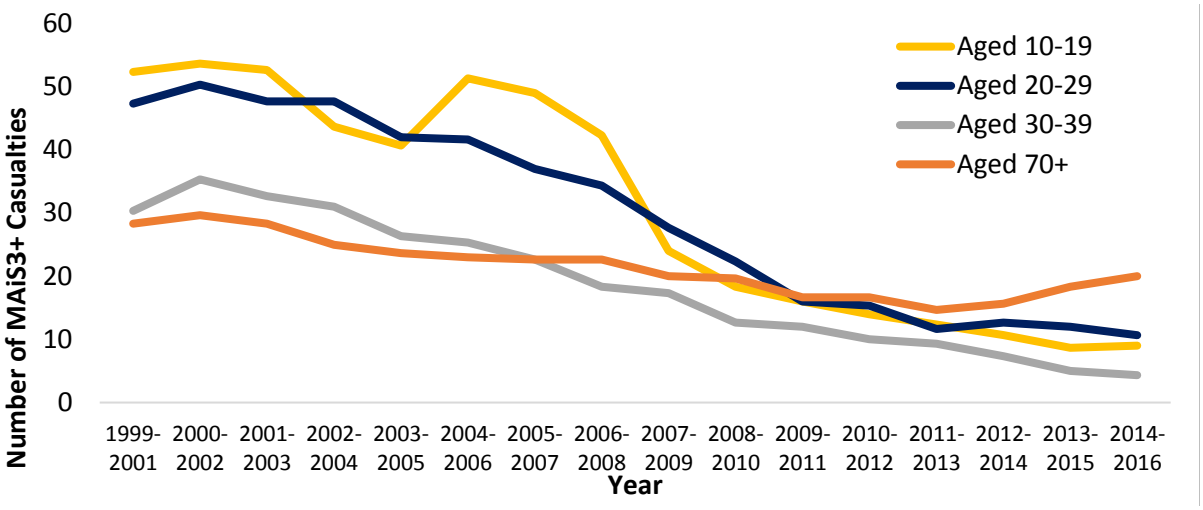
Almost one-quarter (23%) of MAIS 3+ casualties from 2012-2016 were aged 70 and over. This differs markedly from the age profile of overall hospital admissions for road traffic collisions and PSNI serious injuries, where 11% and 9%, respectively, were in this age band. The high proportion of MAIS 3+ casualties which were aged 70 and over is perhaps not surprising given people in this age band are likely to be more vulnerable than those who are younger, and you may expect an older person would suffer more serious injuries if in a collision. Their increased vulnerability/risk is further emphasised by miles travelled data; according to the 2014-2016 Travel Survey in Northern Ireland, persons aged 70 and over travel significantly fewer miles per person per year than any other age band (3,521 miles for persons aged 70+ compared with 5,704 miles for all persons).

When looking at the full trend of available data (1999-2016 for hospital admissions; 2002-2016 for PSNI SIs), it would seem the difference is not as pronounced, with 15% of MAIS 3+ casualties falling within the 70+ category, compared with 8% for both hospital admissions and PSNI SIs. The greater

[2] For MAIS3+ casualties and hospital admissions, this refers to the age at the start of the admission; for PSNI serious injuries it is the age at time of collision.

differences observed more recently is a largely a result of decreases in the number of MAIS3+ casualties aged 10-39 – see Chart 5 below.

Chart 6: MAIS 3+ casualties by age at start of admission, 1999-2016 (Selected age bands) (Northern Ireland)



At the start of the reporting period, the number of MAIS 3+ casualties aged 10-29 were far in excess of those aged 70+, while those aged 30-39 were just slightly above. All four groups have seen a decline over the years; however, the number of older person casualties has not fallen to the same extent, and in more recent years has started to increase. The result is that numbers of casualties aged 70+ are now greater than those in the younger three groups. It is interesting to note that the large spike in casualty numbers mentioned previously, which appeared in 2006, was caused by the 'Aged 10-19' group. Additionally, the decrease in MAIS3+ casualties from 2015 to 2016 can be partly explained by a large decrease in those MAIS 3+ casualties from the 'Aged 20 to 29' group – numbers in this category have fallen by 8 (from 14 to 6, or 57%).

Looking at both age and gender, males aged 20 to 29 accounted for the greatest proportion of overall MAIS 3+ casualties in 2012-2016 (13%); however the proportions in the other age categories were not far behind. The PSNI trend is very different – there we see young male casualties are the most frequently reported, with far fewer in other age categories. In both trends, we see that the proportion of male casualties far exceeds females for the younger age groups; however, there is a large spike in MAIS3+ females aged 70+ that is not seen in the PSNI data. See charts 7 and 8 below.

Chart 7: **MAIS 3+** by age and gender, 2012-2016

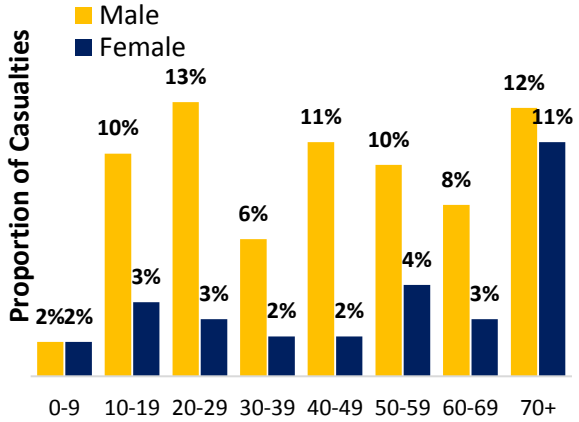
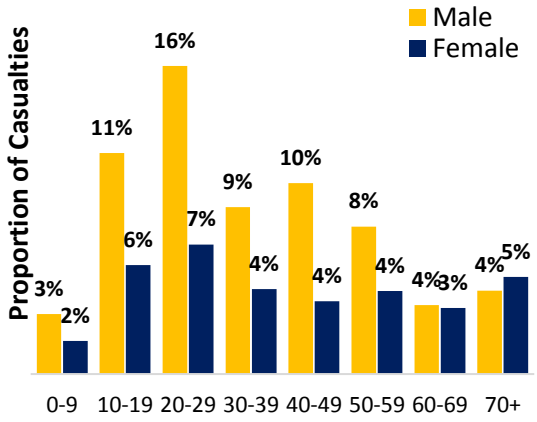


Chart 8: **PSNI SIs** by age and gender, 2012-2016



Road user type

Chart 9: MAIS 3+ casualties compared with PSNI reported seriously injured casualties, by road user type 2012-2016 (Northern Ireland)

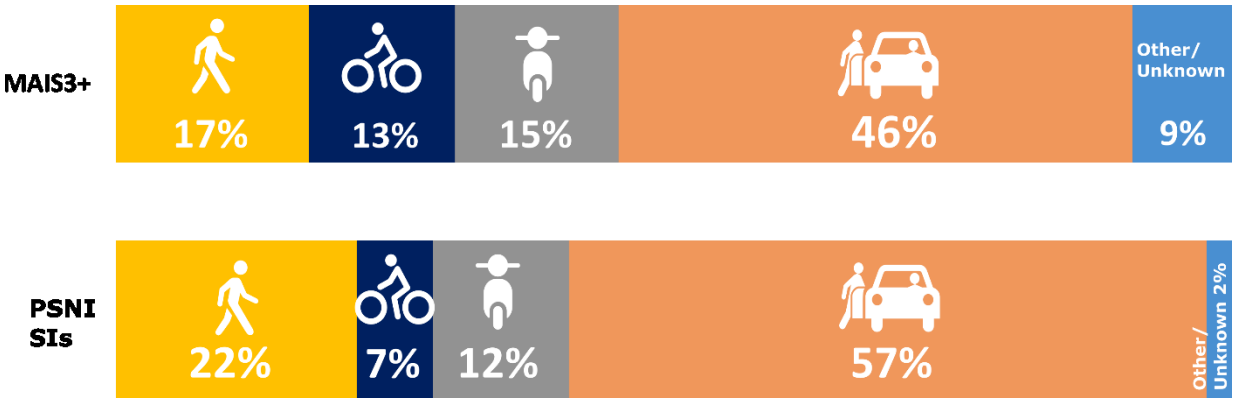


Chart 9 above shows a comparison of MAIS 3+ casualties with PSNI serious injury casualties, by road user type over the period 2012-2016. As expected, the most frequently recorded road user type of the MAIS 3+ casualties was car (46%). However, the equivalent proportion of PSNI Serious Injuries is 57%. Therefore, the numbers of casualties that were travelling by the more vulnerable modes (pedestrian, motorcycle and pedal cycle) made up a greater proportion of the MAIS 3+ total than they did of the PSNI SIs (45% compared with 41%, respectively). Like the over-representation of older people in the MAIS 3+ numbers, this again is not surprising: you might expect that a motorcyclist or cyclist, for example, would suffer injuries at the more severe end of the scale if in a collision than someone travelling by car. However, it should also be noted that GB research has shown that there is significant under reporting of non-fatal pedal cyclist casualties in police data which it would not be unreasonable to assume would also be the case in NI, and which may also help to explain at least part of the difference. It is also interesting that pedestrians account for a slightly higher proportion of PSNI SIs compared to the clinical definition despite their increased vulnerability.

Chart 10: Admissions to hospital for road traffic collisions by road user type and severity, 2012-2016 (Northern Ireland)

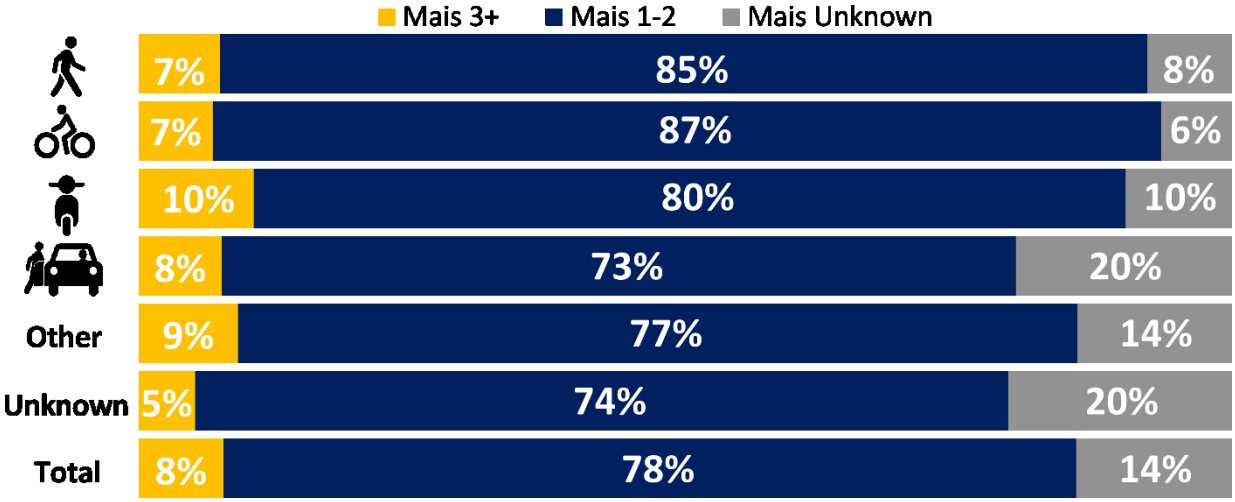


Chart 10 above shows the admissions to hospital in Northern Ireland for road traffic collisions split by road user type and severity of injury. Of the admissions between 2012 to 2016, 8% were MAIS

3+, 78% had a MAIS score of 1 or 2 with the remaining 14% having unknown MAIS. This differs by road user type with motorcyclists having the greatest proportion of admissions that were MAIS 3+ (10%) and pedal cyclists the smallest (7%). This analysis, however, is somewhat confounded by the high percentage of unknowns across the various road user categories; in particular car user admissions, where 20% were unclassified, over double the proportion of the more vulnerable road user groups. It is currently unclear why such a high proportion of car user admissions have been unable to be classified by the MAIS 3+ algorithm.

Chart 11: Number of MAIS 3+ casualties by road user type, 2012-2016 (Northern Ireland)

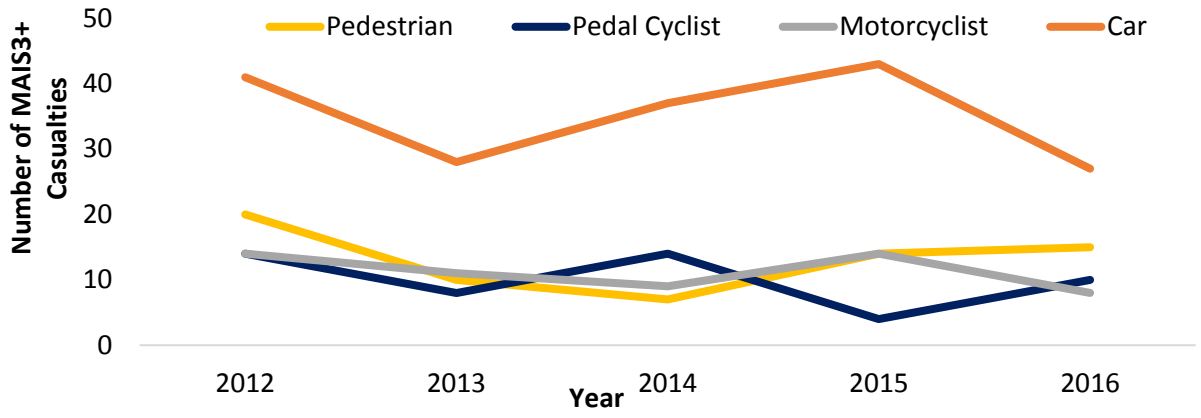
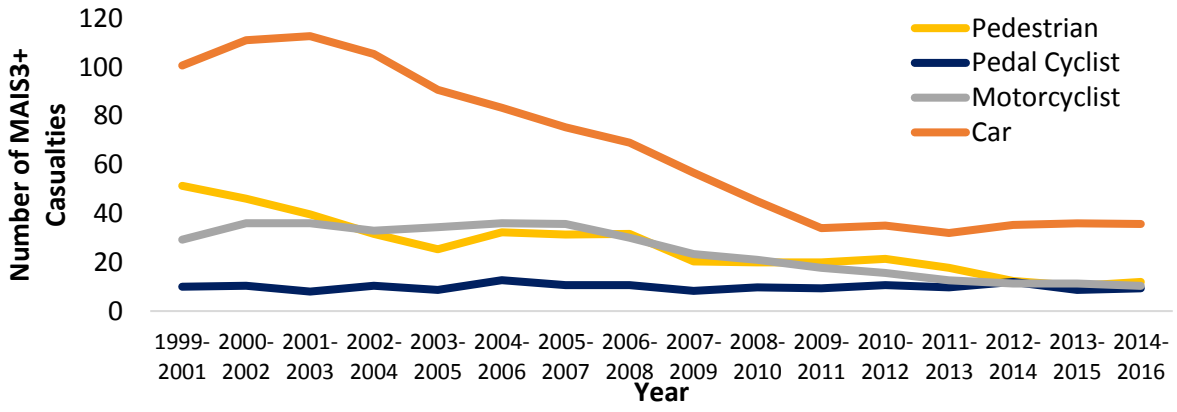


Chart 12: Number of MAIS 3+ casualties by road user type, 1999-2016 (3-Year Rolling Average), (Northern Ireland)



When looking at the number of MAIS 3+ casualties by road user type for the most recent five years, it is clear that each series experiences year-on-year volatility exacerbated by the small numbers in these sub-groups. For that reason, the rolling average chart (Chart 12) has been included to give a clearer indication of which direction the trends are moving. The smoothed trend would suggest there has been little change over the years to Pedal Cyclist MAIS 3+ casualties (the moving average tends to regress to a mean of 10 casualties); however, this must be seen in light of an increased level of cycling over largely the same time period (there has been a 74% increase in average miles cycled per person in NI between 1999-01 and 2014-16). The three other main road user types have all experienced varying degrees of decline. Car User numbers have experienced the greatest decrease, from 113 casualties, on average, in 2001-03 to 32 in 2011-13 which can partly be explained by improvements in vehicle safety. In the most recent years, however, the average number of Car User casualties has shown a slight increase.

Comparison with England[3]

Table 2: Comparison of NI road traffic casualties with England, 1999-2016

Year of admission	MAIS3+/Police SIs		Police SIs/ Admissions		MAIS 3+/Admissions	
	NI	Eng	NI	Eng	NI	Eng
1999	14%	12%	62%	95%	8%	11%
2000	12%	12%	74%	95%	9%	12%
2001	14%	13%	70%	94%	10%	12%
2002	15%	13%	67%	92%	10%	12%
2003	14%	15%	69%	82%	10%	12%
2004	16%	16%	65%	74%	11%	12%
2005	17%	17%	63%	65%	11%	11%
2006	18%	18%	69%	66%	12%	12%
2007	14%	19%	65%	65%	9%	12%
2008	13%	19%	71%	62%	9%	12%
2009	9%	21%	76%	58%	7%	12%
2010	11%	21%	79%	57%	9%	12%
2011	9%	22%	84%	57%	8%	12%
2012	12%	21%	77%		10%	
2013	9%	22%	70%		6%	
2014	10%	22%	72%		7%	
2015	11%	22%	72%		8%	
2016	8%		90%		7%	
Overall	**13%**	**17%**	**70%**	**74%**	**9%**	**12%**

Notes:
[1]England Hospital admission data for road casualties only available up to 2011
[2]2012-2015 MAIS 3+ figures for England have been estimated using police reported casualty data. These figures are currently provisional and will be revised once the Department for Transport receives updated hospital data. There are currently no estimates for 2016.

As stated previously, over the 18 year period 1999-2016, the numbers of MAIS 3+ casualties in Northern Ireland accounted for 13% of PSNI serious injuries. By comparison, the equivalent proportion in England was greater, at 17% (see table 2 above). This difference is greater still if looking at the most recent five years – 10% in NI in 2012-2016 compared with 22% in England in 2011-2015. The number of MAIS 3+ casualties is much lower than the number of seriously injured casualties recorded by police (because MAIS 3+ captures more severe injuries than the definition of serious injury in police reported data); however, it was at first surprising that the proportion was that much smaller in NI (less than half the level in England). Further investigation was carried out to determine whether this variation could be explained, with focus first on how representative police serious injuries were of the true level of collisions that occurred.

Hospital admissions data in England are currently only available up to 2011, however data for 1999 to 2011 shows that police serious injuries accounted for 74% of overall admissions. By comparison, the equivalent figure (1999-2016) in NI was 70%, which would seem to indicate that a broadly similar level of underreporting is present in both jurisdictions across the full period. See table 2 above. However, splitting the time series, we can see that under-reporting of serious injuries in police data is an increasing problem for England (Police SIs/Admissions averaged 92% in 1999-2003, falling to 60% in 2007-2011). By comparison, the trend in NI has been much more stable, and actually shows a slight

[3] At present, hospital admissions data is not available for Scotland or Wales.

increase over the years (in 1999-2003, an average of 68% of hospital admissions were accounted for by PSNI numbers, rising to 76% in 2012-2016). In 2004, when the English proportion was 74% (and therefore closest to the 2012-2016 figure in NI), the MAIS 3+/Police SIs figure in England was 16%, which is much closer to the NI figure of 10% (for 2012-2016). Even so, in proportionate terms it is still 60% higher.

If we next examine hospital admissions, we see that from 1999-2016, MAIS 3+ casualties account for 9% of road casualty hospital admissions in NI, while the equivalent figure is 12% in England (1999-2011), or one-third greater. See table 2 above. Therefore, it looks to be the case that fewer casualties in NI have the most severe injuries, and the question must be asked as to why this may be so. A possible reason is discussed below.

Chart 13: Police recorded road traffic serious injury casualties by road user type in Northern Ireland and England, 2012-2016

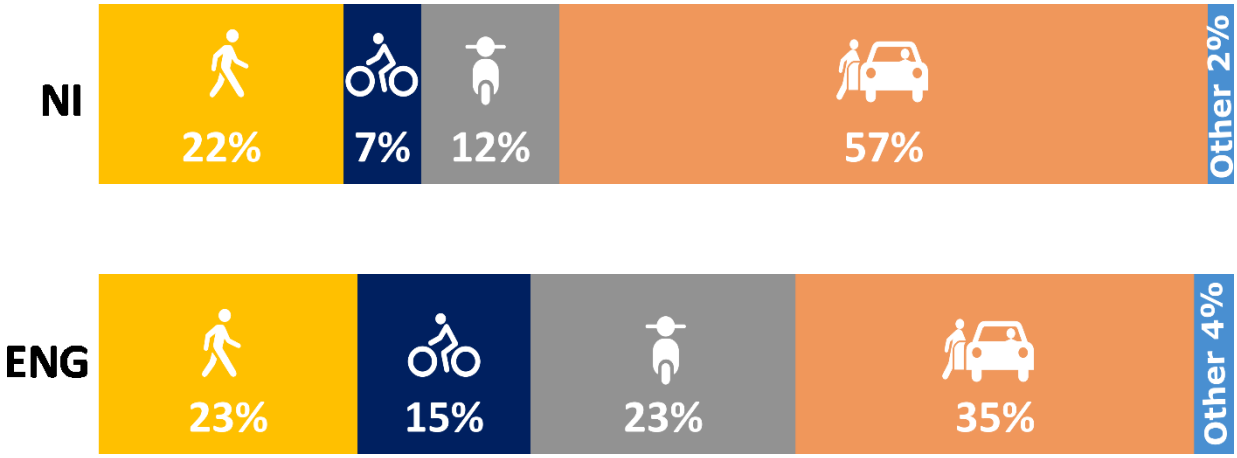


Chart 13 above shows the police reported serious injury road traffic casualties by road user type in Northern Ireland and England for the most recent five years. As expected, the most frequently reported road user type was car in both NI and England; however the proportion varied greatly between the two jurisdictions (57% in NI compared with 35% in England). Therefore, the numbers of casualties that were travelling by the more vulnerable modes (pedestrian, motorcycle and pedal cycle) made up a smaller proportion of the police serious injury casualty total in NI than they did in England (41% compared with 61%, respectively). This road user profile may therefore offer an explanation as to why there were fewer casualties in NI that have the most severe MAIS 3+ injuries: with a smaller proportion of vulnerable road users reported in police serious injury casualties here, and based on the assumption that vulnerable road users are more likely to suffer the most serious injuries if in a collision, it would follow that NI would have a smaller proportion of MAIS 3+ casualties in hospital.

To conclude, comparing NI road traffic casualties with England from 1999-2016, we see that MAIS 3+ casualties in NI account for a smaller proportion of police reported seriously injured than in England; in the five most recent years, 2012-2016, the difference is much greater. Examining the available data to try and explain this difference leads us to two possible reasons: firstly, there appears to be greater underreporting of police serious injuries in England than in NI; and secondly, the profile of the road user type differs across the two jurisdictions, with a smaller proportion of vulnerable road users in the NI police data being reflected in fewer MAIS 3+ hospital admissions here.

Methodology

The AIS

When a patient is admitted to hospital, clinical details of their conditions are coded to the International Classification of Diseases 10th revision (ICD-10)[4]. A standard look-up table has been developed by the European Commission to convert the ICD-10 diagnostic codes of road traffic related hospital admissions to the Abbreviated Injury Scale (AIS). This then provides for international comparisons of road traffic serious injuries on a consistent basis.

The AIS severity score is an ordinal scale of 1 to 6 (1 indicating a minor injury and 6 being unsurvivable) developed by the Association for the Advancement of Automotive Medicine (see table below). An admission to hospital may have a number of different injuries, with differing severities. The Maximum Abbreviated Injury Scale (MAIS) is therefore the AIS score of the most severe injury that a patient sustains; if a patient has one injury with an AIS score of 2 (moderate) and another with AIS of 4 (severe) then their MAIS score is 4. Patients with a MAIS of 3 or above (MAIS 3+) are considered to be clinically seriously injured.

Abbreviated Injury Scale

AIS-code	Injury	Example
1	Minor	Superficial laceration
2	Moderate	Fractured sternum
3	Serious	Open fracture of humerus
4	Severe	Perforated trachea
5	Critical	Ruptured liver with tissue loss
6	Unsurvivable	Total severance of aorta
9	Not known	

Producing the MAIS 3+ numbers used in this report

In addition to providing details of the injuries sustained, the ICD-10 codes also provide information on how a patient's injuries were caused. Hospital patients who have an external cause of injury relating to a road transport collision (codes V01 to V89, excluding V81) were extracted from the hospital admissions inpatient database over 1999 to 2015. Only casualties whose injuries related to collisions that occurred on a public highway (i.e. road traffic collisions) were included. Each admission was therefore assigned to a MAIS category as follows:

- MAIS 3+ if any of the patient's codes were AIS 3 or above
- MAIS<3 if all of the patient's codes were AIS1-2
- Unknown if all of the patient's codes were unknown
- Unknown if none of the patient's codes were AIS 3 or above and at least one code was unknown

[4] For more information on ICD-10 see apps.who.int/classifications/icd10/browse/2016/en#!/IX

Future Work

Our intention is to provide an annual update going forward. Future work will also investigate reasons for the differences in the unclassified MAIS category across road user groups.