Department for Transport

Estimating clinically seriously injured (MAIS3+) road casualties in the UK

About this article

This article provides provisional estimates of the number of people seriously injured in road traffic accidents in the UK for 1999 to 2015 using a clinical definition. These estimates have been produced using data on road casualties admitted to hospital contained in Hospital Episode Statistics (HES) as well as data on road casualties in road traffic accidents reported to the police (Stats19). This definition is based on the Maximum Abbreviated Injury Scale (MAIS3+).

Updated MAIS3+ estimates as well as further analysis of length of stay in hospital, body region and injury type will be provided in future publications.

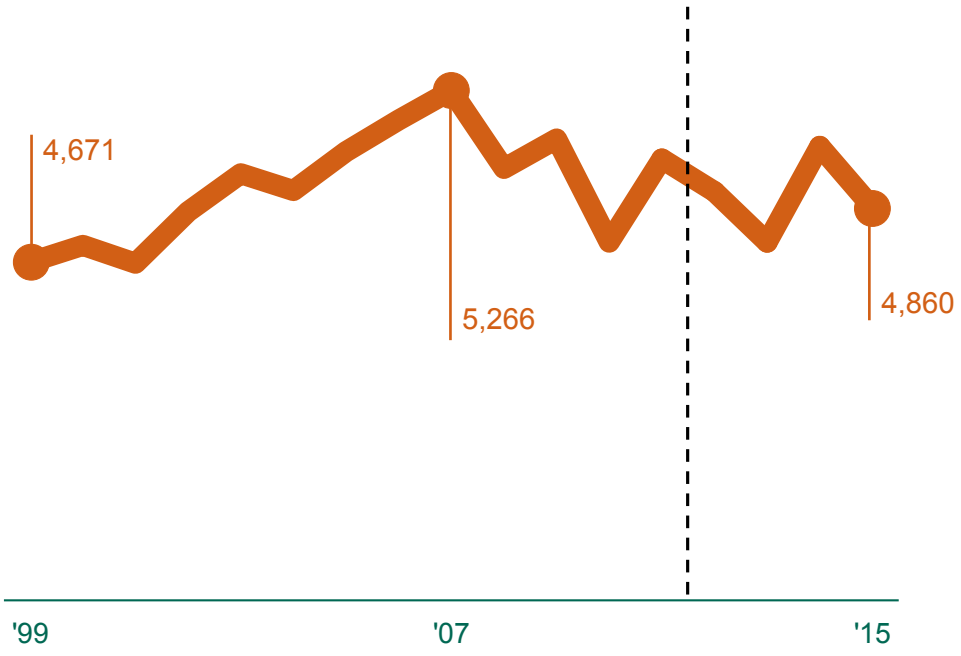
In this article

The estimated number of clinically seriously injured (MAIS3+) casualties in road traffic accidents in the UK has remained relatively unchanged over 1999 to 2015.

What is MAIS3+?

The Abbreviated Injury Scale (AIS) severity score is an ordinal scale of 1 to 6 (1 indicating a minor injury and 6 being maximal). A casualty that sustains an injury with a score of 3 or higher on the AIS is classified as clinically seriously injured (MAIS3+).

Estimated MAIS3+ casualties: UK, 1999-2015



* 2012-2015 MAIS3+ figures have been estimated using police reported casualty data. These figures are currently provisional and will be revised once the Department receives updated hospital data.

RESPONSIBLE STATISTICIAN: Name: Daryl Lloyd Email: roadacc.stats@dft.gsi.gov.uk
FURTHER INFORMATION: Media: 020 7944 6898 Public: 020 7944 6595

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HES data

The Hospital Episode Statistics (HES) inpatient database is compiled by NHS Digital. It contains data on inpatient admissions to hospitals in England. Each record represents an episode of care under a particular consultant, and contains clinical details of the patient's condition coded to the International Classification of Diseases 10th revision (ICD-10). This coding allows inpatients whose injuries have been caused by a road traffic accident to be identified. See HES data section for more information.

What is MAIS3+?

The Abbreviated Injury Scale (AIS) severity score is an ordinal scale of 1 to 6 (1 indicating a minor injury and 6 being maximal). A casualty that sustains an injury with a score of 3 or higher on the AIS is classified as clinically seriously injured (MAIS3+). The MAIS3+ estimates presented in this article have been produced using data on road casualties admitted to hospital contained in Hospital Episode Statistics (HES) as well as data on road casualties in road traffic accidents reported to the police (Stats19). See introduction to MAIS3+ and methodology sections for more information.

How does MAIS3+ differ from police-reported data?

The MAIS3+ estimates are based on hospital admissions data sourced from HES. This dataset contains clinical information of the patient's injuries coded to ICD-10. The severity of a patient's injuries is then determined using the patient's ICD-10 codes. The patient's ICD-10 codes are converted to AIS scores using a lookup file. The AIS scores associated with the patient's injuries are then used to determine whether the patient has sustained a MAIS3+ injury.

In contrast, the classification of injury severity in police reported data (Stats19) is based on the judgement of the reporting police officer so is not based on medical expertise. The trend shown in the estimated number of MAIS3+ casualties and the number of police reported seriously injured casualties is different. See comparison with police reported seriously injured casualties section for more information.

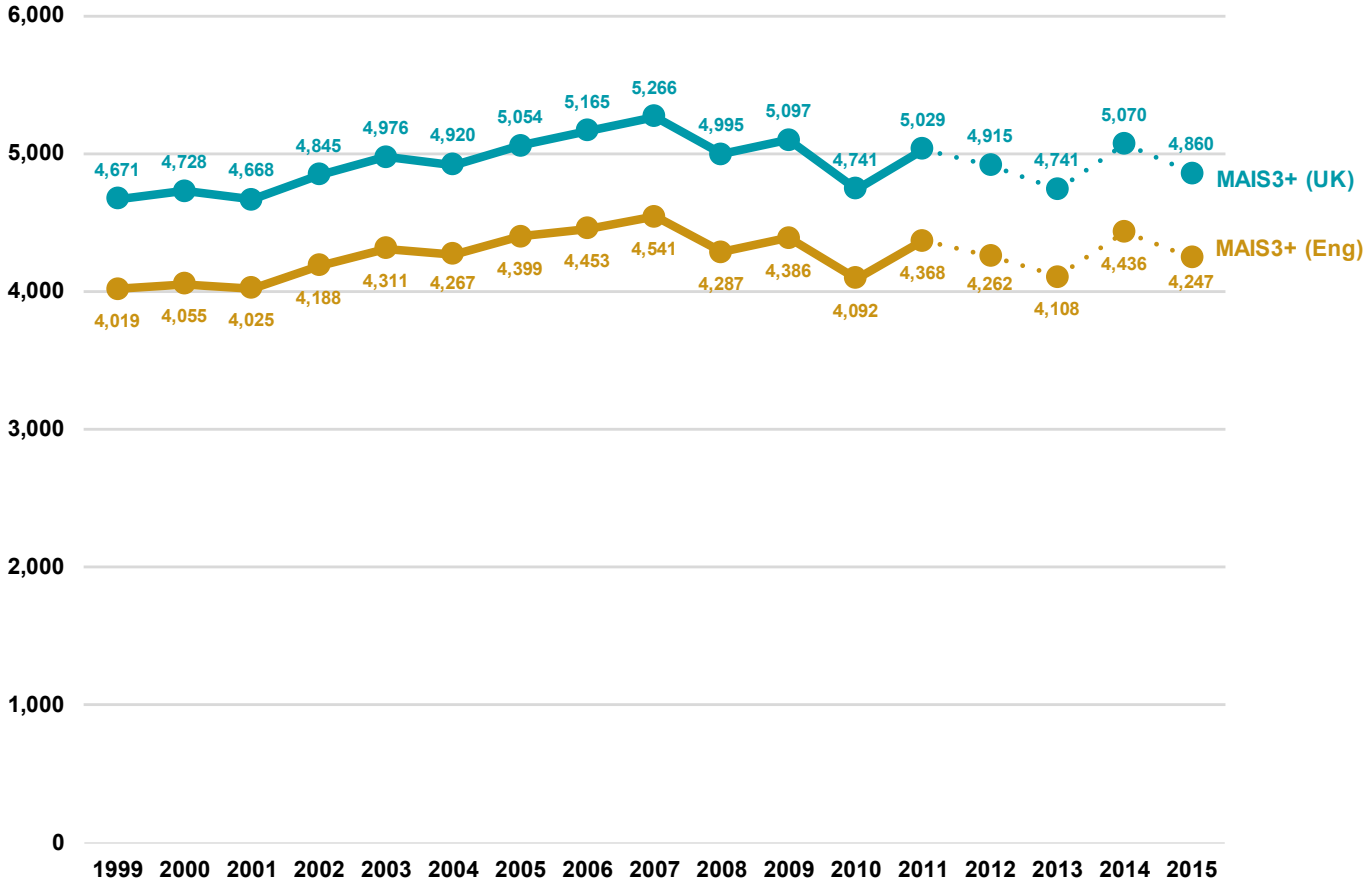
Analysis of MAIS3+ casualties

This report contains the first estimates for the total number of people admitted to hospitals in the United Kingdom with a clinically defined serious injury following a road traffic accident. The figures are based on hospital data from hospitals in England and then have been scaled up to cover Scotland, Wales and Northern Ireland using the police-recorded casualty data. Further information on how the scaling has been carried out can be found in the methodology section.

Chart 1 shows provisional estimates for the number of clinically seriously injured (MAIS3+) road casualties in England and the UK over 1999 to 2015. The key pattern is that the number of MAIS3+ casualties in the UK grew from around 4,700 in 1999 to a peak of just over 5,250 in 2007. There have been some indications that the numbers have dropped slightly since then, albeit with considerable year on year variability. The last year for which we currently have hospital data available is 2011, for which we estimate that there were just over 5,000 MAIS3+ casualties.

The estimates since 2011 are based on police-recorded data for the whole of the UK with a correction factor based on the 2011 hospital data. These figures will be finalised once we receive 2012 to 2015 hospital data from NHS Digital. The figures for this period are therefore subject to additional uncertainty and are provisional at this stage.

Chart 1: Estimated number of MAIS3+ casualties in England and the UK, 1999-2015



* 2012-2015 MAIS3+ figures for England and the UK have been estimated using police reported casualty data plus the 2011 correction factor. These figures are currently provisional and will be revised once the Department receives updated hospital data.

Road user type

Of the estimated number of MAIS3+ casualties for the UK over 1999 to 2011, the majority were **car occupants** (33 per cent), **motorcyclists** (23 per cent) and **pedestrians** (22 per cent). The breakdown is fairly similar to the split by road user type for police reported seriously injured casualties (chart 2). However, **pedal cyclists** account for a higher proportion of the estimated MAIS3+ casualties (14 per cent) than they do for police-reported seriously injured casualties (8 per cent). This difference could be due to the significant **under reporting of non-fatal pedal cyclist casualties** that occurs in the police data.

Of the admissions to hospital over 1999 to 2011 for road traffic accidents where the patient survived or died after 30 days of being admitted in England, 12 per cent were MAIS3+, 69 per cent had a MAIS of 1 or 2 with the remaining 19 per cent having unknown MAIS. However, this differs by road user type (chart 3) with **motorcyclists** having the largest proportion of admissions that were MAIS3+ (15 per cent) and **pedal cyclists** the smallest (9 per cent).

Chart 2: Estimated number of MAIS3+ casualties compared with police-reported seriously injured casualties: UK, 1999-2011

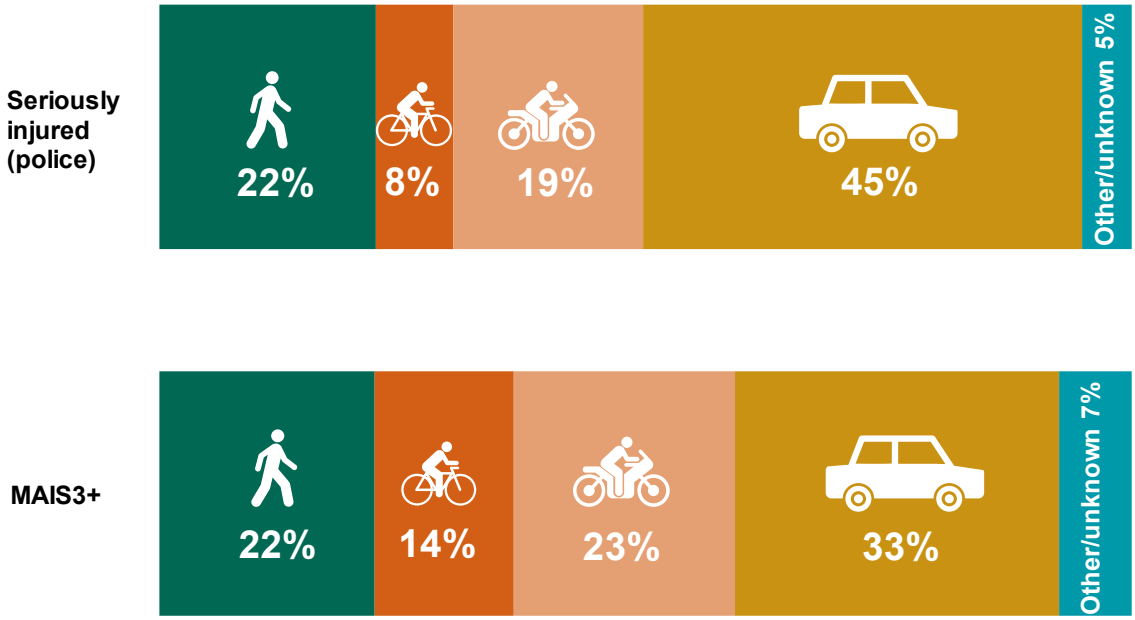
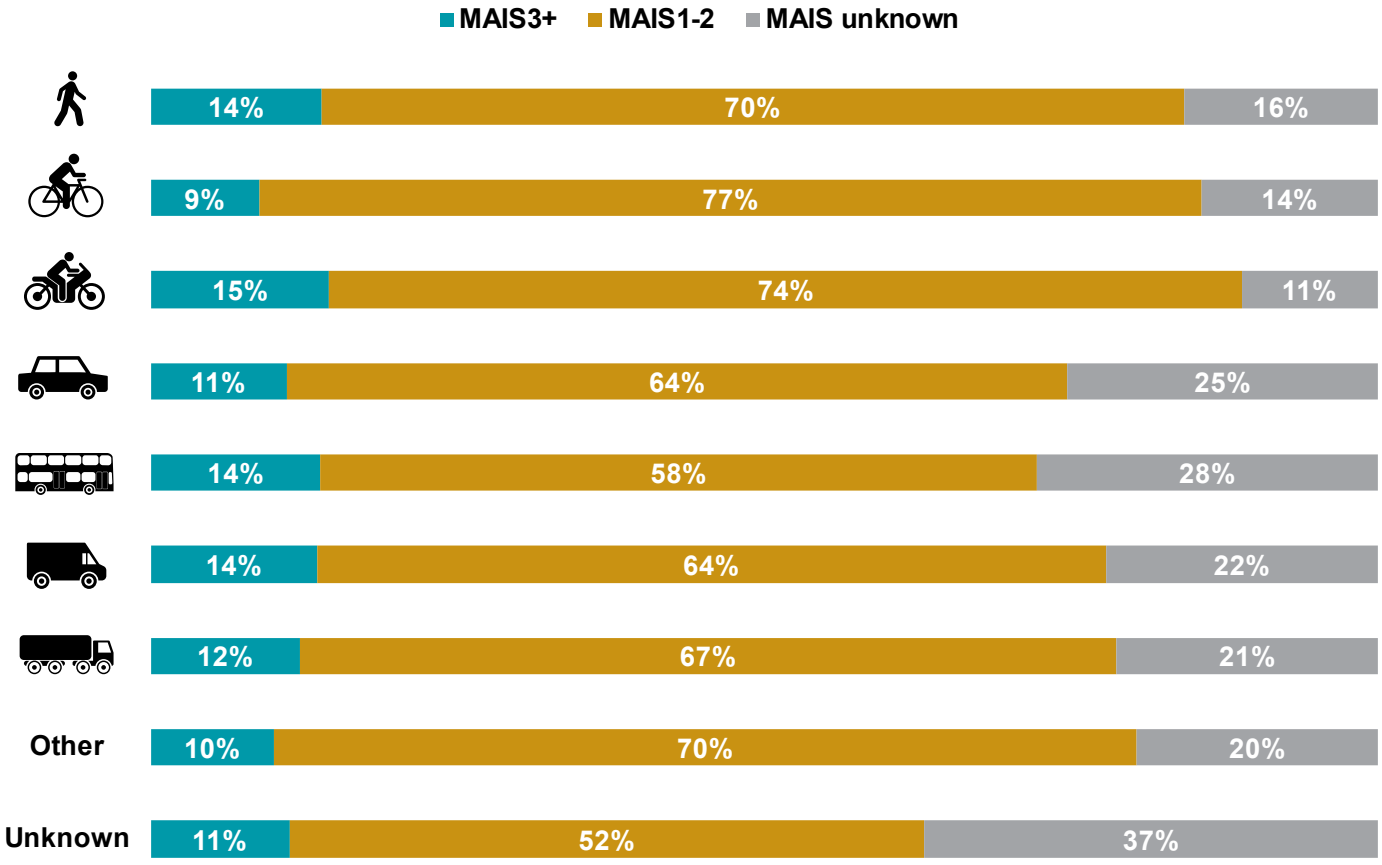
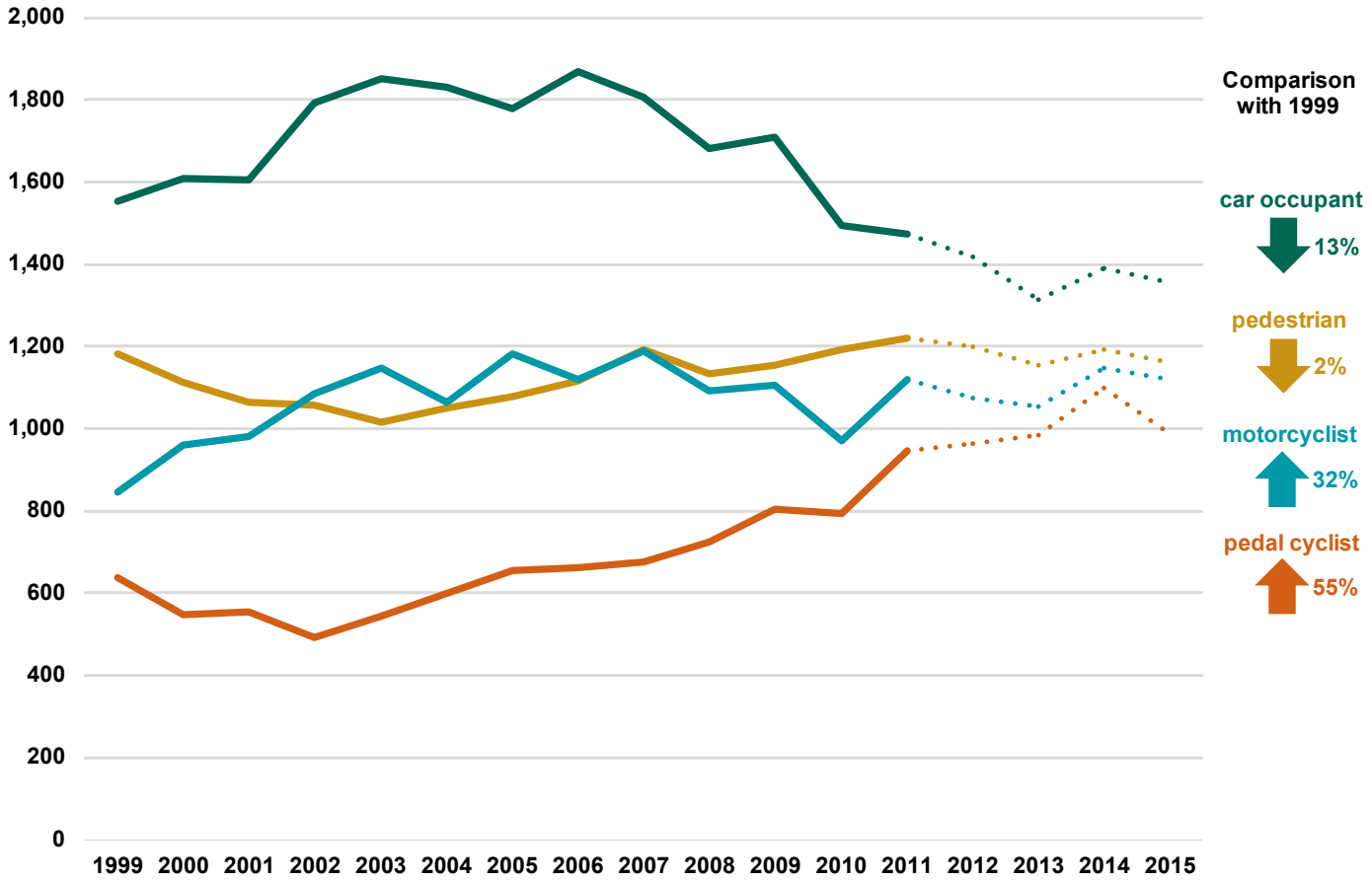


Chart 3: Breakdown by road user type of admissions to hospital for road traffic accidents where the patient survived or died after 30 days of being admitted: England, 1999-2011



The **trend in the estimated number of MAIS3+ casualties differs for the main road user types**. Car occupant MAIS3+ casualties have fallen by 13 per cent over 1999 to 2015 with pedestrian MAIS3+ casualties relatively unchanged over the same period (a 2 per cent decrease). However, there have been large increases in the number of MAIS3+ casualties for pedal cyclists and motorcyclists over 1999 to 2015 (55 per cent and 32 per cent respectively). The increase for pedal cyclists could be explained by the rising volume of cycle traffic (on-road pedal cycle traffic in GB rose by 28 per cent over 1999 to 2015).

Chart 4: Estimated number of MAIS3+ casualties by selected road user types: UK, 1999-2015



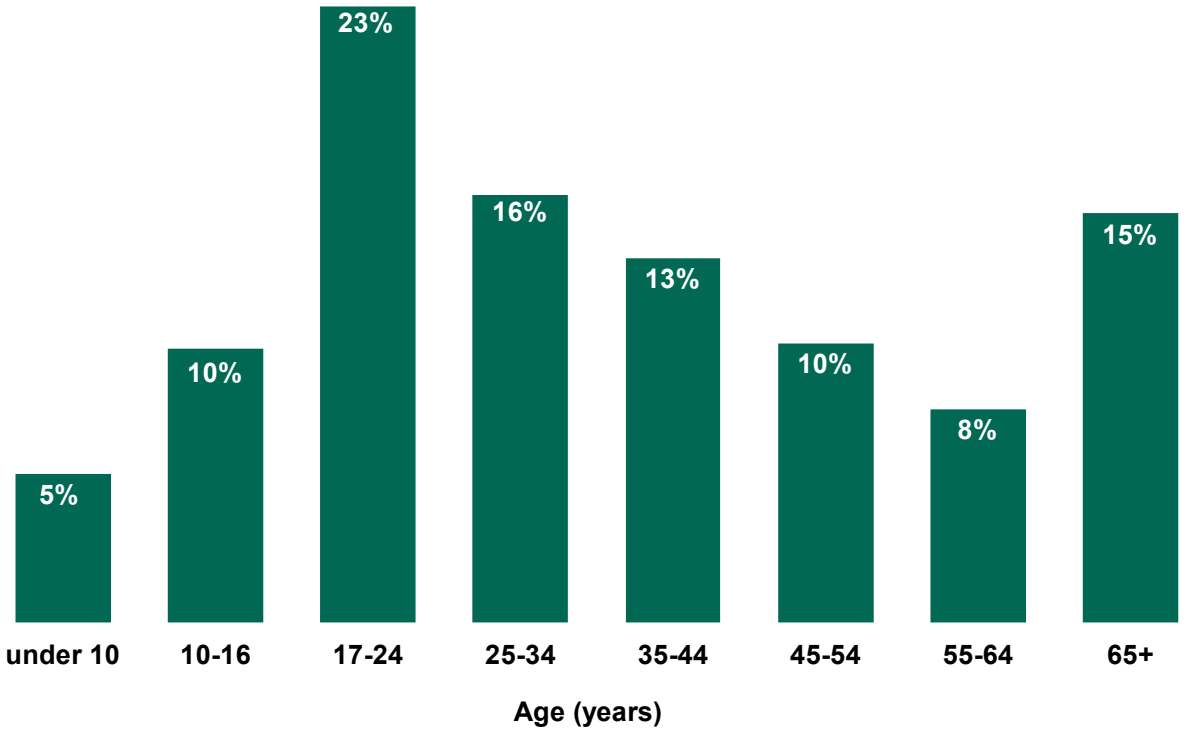
* 2012-2015 MAIS3+ figures have been estimated using police reported casualty data. These figures are currently provisional and will be revised once the Department receives updated hospital data.

Age and gender

Males accounted for 75 per cent of the estimated number of MAIS3+ casualties in the UK over 1999 to 2011 with people aged 17 to 24 accounting for nearly 25 per cent (chart 5). The high proportion of MAIS3+ casualties which were aged 65 and over (15 per cent) is not surprising given the vulnerability of many people in this age group.

3 in 4
MAIS3+ casualties are male

Chart 5: Estimated number of MAIS3+ casualties by age at start of admission: UK, 1999-2011



Looking at both age and gender, **males aged 17 to 24** accounted for 18 per cent of the estimated MAIS3+ casualties over 1999 to 2011.

Tables

Estimated number of MAIS3+ road casualties, table RAS55050.

HES data

The **Hospital Episode Statistics (HES)** inpatient database is compiled by **NHS Digital**. It contains data on inpatient admissions to hospitals in England. Each record represents an episode of care under a particular consultant, and contains clinical details of the patient's condition coded to the **International Classification of Diseases 10th revision (ICD-10)**. This coding allows inpatients whose injuries have been caused by a road traffic accident to be identified. Casualties treated in Accident and Emergency departments who are not subsequently admitted to a hospital bed are not included in the HES inpatient database. There are many definitional differences between HES and Stats19; for example, HES covers only patients admitted to a hospital bed whereas Stats19 casualty records relate to those injured in traffic accidents on the public highway that become known to the police.

Further information

More information on Hospital Episode Statistics can be found at: digital.nhs.uk/hes

More information on the International Classification of Diseases 10th revision (ICD-10) can be found at: apps.who.int/classifications/icd10/browse/2016/en#!/IX

Defining seriously injured casualties

For the purposes of **police-reported accident data (Stats19)**, a **seriously injured casualty** is defined as an injury for which a person is detained in hospital as an inpatient, or any of the following injuries whether or not they are detained in hospital: fractures, concussion, internal injuries, crushings, burns (excluding friction burns), severe cuts, severe general shock requiring medical treatment and injuries causing death 30 or more days after the accident. The police classify the severity of a casualty using information available within a short time of the accident (often at the scene). Therefore the classification of severity will generally not reflect the results of a medical examination or medical expertise. This means that there can be misclassifications of seriously and slightly injured casualties in the Stats19 data (i.e. seriously injured casualties that are classified as slightly injured and vice versa) which makes monitoring of the number of seriously injured casualties difficult. This approach is taken elsewhere in Europe resulting in similar misclassifications. As a result, the European Commission has asked countries to make use of hospital data to estimate the number of seriously injured road casualties using the **MAIS3+ indicator**.

Definitions

A full list of the definitions used in Stats19 data can be found at: www.gov.uk/government/uploads/system/uploads/attachment_data/file/462818/reported-road-casualties-gb-notes-definitions.pdf

MAIS3+ casualties

The **Abbreviated Injury Scale (AIS)** severity score is an ordinal scale of 1 to 6 (1 indicating a minor injury and 6 being maximal) developed by the **Association for the Advancement of Automotive Medicine**. An AIS score of 9 is used to describe injuries where not enough information is available for more detailed coding. The **Maximum Abbreviated Injury Scale (MAIS)** is the AIS score of the most severe injury that a patient sustains. For instance, if a patient has one injury with an AIS score of 2 (moderate) and another with an AIS of 4 (severe) then their MAIS score is 4. Patients with a MAIS of 3 or above (MAIS3+) are considered to be clinically seriously injured.

Table 1: 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	Maximum	total severance of aorta
9	Not further specified	

Further information

More information on the AIS can be found at: www.aaam.org/about-ais.html

AIS scores are based on the **'threat to life'** associated with an injury. For injuries with an AIS score of 6 the probability of death is 100 per cent which makes them virtually unsurvivable. However, in some cases patients can sustain injuries such as a traumatic brain injury with an AIS of 6 but still survive.

Preliminary guidelines for countries to estimate the number of seriously injured road casualties (MAIS3+) have been developed by the **European Commission** (www.safetycube-project.eu/safetycube-workshop-on-serious-road-injuries-the-hague-may-2016/). These guidelines have been applied to HES data in order to produce provisional estimates of MAIS3+ casualties for the UK over 1999 to 2015.

Methodology for estimating MAIS3+ casualties

Patients who have an **external cause of injury relating to a road transport accident** (codes V01 to V89, excluding V81) were extracted from the HES inpatient database over 1999 to 2011. These patients were then further filtered to exclude accidents that did not occur on the public highway. In addition patients that were recorded as having died within 30 days of being admitted to hospital were excluded. However, to be consistent with the Stats19 seriously injured definition, patients that died after 30 days of being admitted to hospital were included.

Admission records in HES data are based on **periods of care ('episodes')** under a particular consultant, so patients can be counted more than once (e.g. if they transfer to another consultant). Episodes join together to form 'spells', with each spell representing care under one hospital provider.

A single patient may therefore have more than one episode (or spell) of care arising from a single accident. Therefore some **data cleaning (de-duplication)** was required to identify records relating to the same patient and the same accidents. However, there is also the possibility that a patient may have multiple admissions as a result of involvement in more than one accident. Multiple admissions from a single accident were reduced to a single record where possible, but multiple admissions for more than one accident were not.

This **de-duplication** was carried out by first grouping together all episodes for the same patient by chronological order of episode start date. If there were more than 14 days between the end of one episode and the start of the next, then this was assumed to be related to two separate accidents. For the MAIS3+ estimate, only the episode with the earliest date was selected for each accident. Table 1 below shows the number of records in the hospital data file before and after this de-duplication process.

This filtered data set represents the number of **admissions to hospital for road traffic accidents where the patient either survived or died after 30 days of being admitted to hospital** (see table 2). Please note that the year of the admission date may not correlate exactly with the year of the accident date e.g. a person admitted to hospital on 01/01/2010 for an accident on 31/12/2009 will be included in 2010.

Table 2: Admissions to hospital for road traffic accidents where the patient survived or died after 30 days of being admitted: England, 1999-2011

Year of admission	HES records	Admissions[1]
1999	39,118	35,346
2000	38,425	34,673
2001	38,042	34,317
2002	36,853	33,849
2003	37,986	35,555
2004	38,539	36,324
2005	40,960	38,617
2006	39,844	37,393
2007	39,368	37,027
2008	37,906	35,736
2009	39,010	36,874
2010	36,192	34,369
2011	37,008	35,471

**includes a small number of admissions where patient died after 30 days of being admitted*

1. After de-duplication

Under each episode, a **patient can have up to 20 diagnoses relating to their condition**. A lookup file has been developed by the Advancement of Automotive Medicine to determine the AIS score for ICD-10 codes relating to consequences of external causes (S and T codes). This lookup file was used to determine the AIS score for each of the patient's diagnoses. This enabled the number of MAIS3+ admissions to hospital for road traffic accidents where the patient survived or died after 30 days of being admitted to be estimated (referred to as MAIS3+ casualties for the rest of the document). However, it was not always possible to determine the MAIS score for admissions which had S or T ICD-10 codes which could not be matched to the lookup file or the AIS was indeterminable from the lookup. These cases were categorised as unknown. Each admission was assigned to a MAIS category as follows:

- MAIS3+ if any of the patient's S or T ICD-10 codes were AIS 3 or above
- MAIS<3 if all of the patient's S or T ICD-10 codes were AIS1-2
- Unknown if all of the patient's S or T ICD-10 codes were unknown
- Unknown if none of the patient's S or T ICD-10 codes were AIS 3 or above and at least one of the S or T ICD-10 codes was unknown

The table below gives the **estimated number of MAIS3+ casualties in England**. For instance, of the 35,471 admissions for road traffic accidents where the patient survived or died after 30 days of being admitted in 2011, 4,368 were MAIS 3 or above (MAIS3+).

Table 3: Admissions to hospital for road traffic accidents where the patient survived or died after 30 days of being admitted: England, 1999-2011

Year of admission	HES records	Admissions[1]	MAIS3+	% of admissions
1999	39,118	35,346	4,019	11.4%
2000	38,425	34,673	4,055	11.7%
2001	38,042	34,317	4,025	11.7%
2002	36,853	33,849	4,188	12.4%
2003	37,986	35,555	4,311	12.1%
2004	38,539	36,324	4,267	11.7%
2005	40,960	38,617	4,399	11.4%
2006	39,844	37,393	4,453	11.9%
2007	39,368	37,027	4,541	12.3%
2008	37,906	35,736	4,287	12.0%
2009	39,010	36,874	4,386	11.9%
2010	36,192	34,369	4,092	11.9%
2011	37,008	35,471	4,368	12.3%

**includes small number of admissions where patient died after 30 days of being admitted.*

1. After de-duplication

Estimating MAIS3+ casualties for the UK

The HES data collated by **NHS Digital** covers England only and the Department does not have access to equivalent data for Scotland, Wales or Northern Ireland. Estimates for MAIS3+ casualties in the **UK** were derived by **applying correction factors to UK police recorded seriously injured and slightly injured road casualties**. These correction factors were calculated from the ratio between the estimated number of MAIS3+ casualties and the number of injured casualties in England from Stats19 data. The correction factors were calculated for each combination of the following variables: year, gender, age group and road user type. The estimated number of MAIS3+ casualties in England and the UK is shown in chart 1 for 1999 to 2011. As an example, there were an estimated 5,029 MAIS3+ casualties in the UK in 2011, scaled up from an estimated 4,368 for England. The equation below gives the estimated number of MAIS3+ casualties in the UK for each combination of year, gender, age group and road user type:

$$MAIS3+_{y,g,a,u}{}^{UK} = \frac{MAIS3+_{y,g,a,u}{}^{Eng}}{C_{y,g,a,u}{}^{Eng}} \times C_{y,g,a,u}{}^{UK}$$

$MAIS3+_{y,g,a,u}{}^{UK}$ is the number of MAIS3+ casualties in the UK for the given year, gender, age group and road user type to be estimated

$MAIS3+_{y,g,a,u}{}^{Eng}$ is the number of MAIS3+ casualties in England for the given year, gender, age group and road user type

$C_{y,g,a,u}{}^{Eng}$ is the number of police-reported seriously and slightly injured casualties in England for the given year, gender, age group and road user type

$C_{y,g,a,u}{}^{UK}$ is the number of police-reported seriously and slightly injured casualties in the UK for the given year, gender, age group and road user type

For instance, in 2011 there were an estimated 255 MAIS3+ **male car occupants aged 17-24** in England. There were 13,934 of this group injured in the police-reported data in England and 16,715 in the UK. Therefore, the estimated number of MAIS3+ male car occupants aged 17-24 in the UK is calculated as follows:

$$MAIS3+ = \frac{255}{13{,}934} \times 16{,}715 = 306$$

Aggregating the estimated MAIS3+ for each year, gender, age group and road user type combination gives an overall **MAIS3+ casualty estimate for the UK** in 2011 of 5,029.

The Department only has access to hospital data for England over the period 1999 to 2011. However, police reported casualty data for the UK is available for 2012 to 2015. The number of **MAIS3+ casualties in the UK and England for 2012 to 2015 were estimated** by applying the same ratio of MAIS3+ to police reported injured casualties for the combinations of gender, age group and road user type over 2012 to 2015 as occurred in 2011.

Uncertainty

There is uncertainty in the 1999 to 2011 estimates of UK MAIS3+ casualties as we have **assumed the same ratio of MAIS3+ casualties to police reported injured casualties** for each combination of gender, age group and road user type in Wales, Scotland and Northern Ireland as occurred in England. These ratios may differ between countries due to differences in population and traffic levels. Due to the absence of hospital data for 2012 to 2015 the UK MAIS3+ casualty estimates for these years are even more uncertain. The ratio of MAIS3+ to police reported injured casualties for the combinations of gender, age group and road user type over 2012 to 2015 may not necessarily be the same as in 2011. However, **other European countries have adopted a similar methodology**. In Belgium hospital data over 2009 to 2011 has been used to estimate the number of MAIS3+ road casualties over 2005 to 2013.

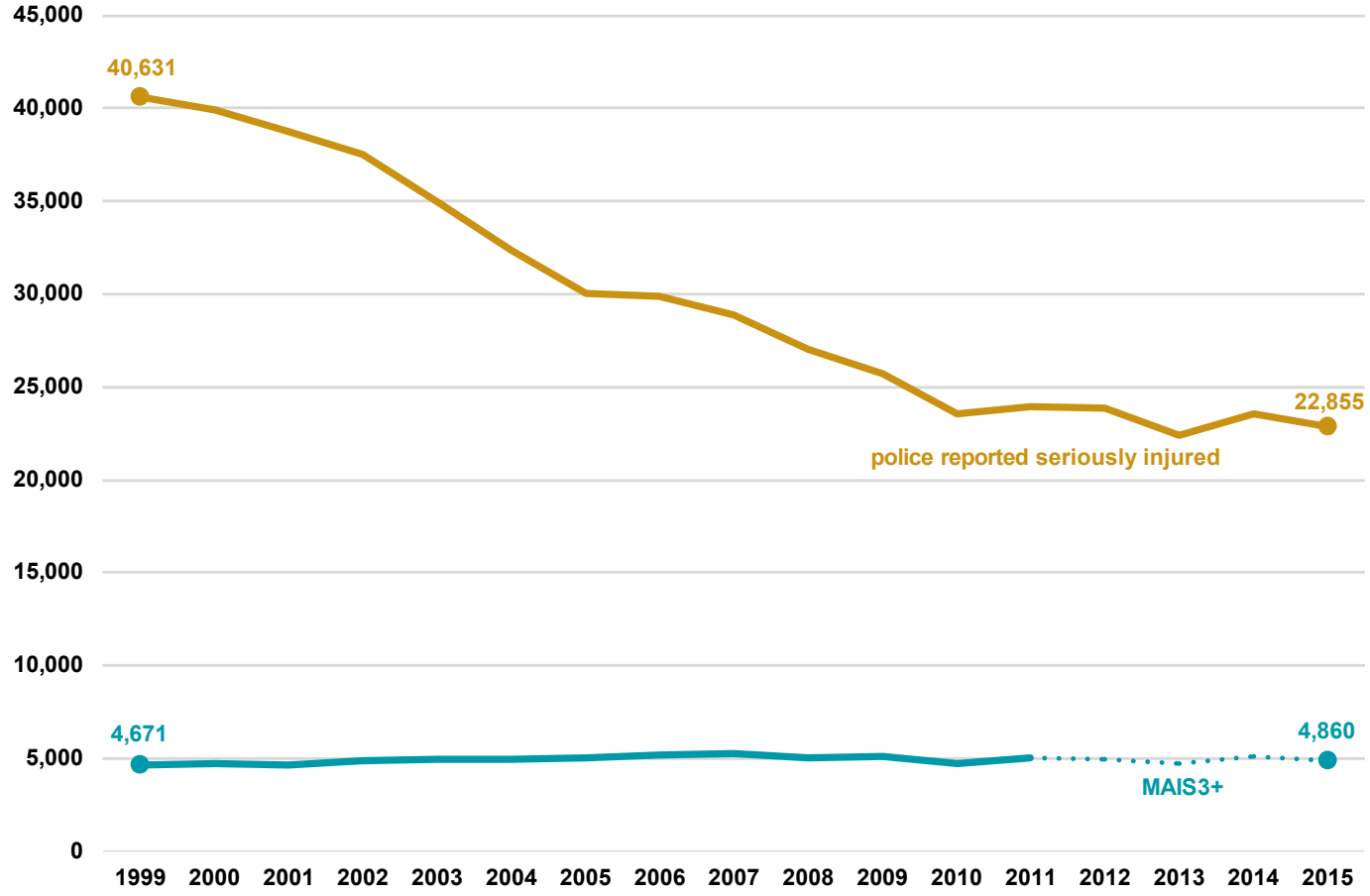
Further information

More information on the Belgium methodology for estimating MAIS3+ road casualties can be found here.

Comparison with police reported seriously injured casualties

The **estimated number of MAIS3+ casualties in the UK is lower than the number of seriously injured casualties reported in police data**. As an example, in 2015 there were an estimated 4,860 MAIS3+ casualties in the UK compared with 22,855 seriously injured casualties reported in police data in the UK. This is likely to be due to MAIS3+ capturing more severe injuries than the definition of serious injury in police reported data. In addition, a number of patients admitted to hospital will not have injuries severe enough to be classified as MAIS3+.

Chart 6: Estimated MAIS3+ casualties compared with police reported seriously injured casualties: UK, 1999-2015



* 2012-2015 MAIS3+ figures have been estimated using police reported casualty data. These figures are currently provisional and will be revised once the Department receives updated hospital data.

The **estimated number of MAIS3+ casualties in the UK also shows a different trend to the number of seriously injured casualties reported in police data**. The estimated number of MAIS3+ casualties has remained relatively unchanged over 1999 to 2015. However, the number of seriously injured casualties reported in police data has fallen by 44 per cent over the same period. By definition MAIS3+ includes very severe injuries such as traumatic brain injuries whereas the definition of a serious injury in police data can include more moderate injuries such as severe cuts which do not require admission to hospital. It may be that the number of 'more moderate' serious

injuries in road traffic accidents are falling but severe injuries, i.e. those classified as MAIS3+, are not. Improved emergency department care may also be contributing to more patients with severe injuries surviving to hospital admission.

The decline in police reported seriously injured casualties could also be explained by **fewer serious injuries being reported to the police** each year. This implies that under reporting may be an increasing problem. More research is needed to understand if this is the case.

Further information

The Department has previously undertaken work to link police recorded Stats19 data to HES data. Further information can be found at: www.gov.uk/government/uploads/system/uploads/attachment_data/file/230598/hes-linkage.pdf

Future work on MAIS3+

There are a number of areas of work which the Department will take forward in this area:

- We are currently working with NHS Digital to get access to HES data for 2012 to 2015 and onwards in the future. The provisional figures will be revised with the new data and the tables will be updated with post-2015 data in the future.
- The estimates for the UK are currently based on the ratio between MAIS3+ and police-recorded casualties in England, applied to the police-recorded casualties in Scotland, Wales and Northern Ireland. This includes an assumption that the ratio remains true in all four countries. We will work with the devolved governments to explore getting access to hospital data for all four countries, thereby removing the need for a correction factor.
- The ICD-10 codes are currently converted to AIS scores using a lookup provided by the European Commission. Member States are aware that the lookup is missing some codes used in Europe, so we expect to receive a new version of the lookup in the future. This will allow us to get a MAIS score for some of the currently unscored casualties.
- The EC lookup is a binary system: it only indicates whether each diagnostic code is MAIS3+ or not. Ideally the lookup will be expanded to give individual AIS scores of 1 to 6. If and when this is made available we will be able to produce statistics based on other MAIS thresholds.