Title: Epidemiology of Adolescent Trauma in England: a review of TARN data 2008-2017

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On behalf of PERUKI

Conflict of interest

SM, DJ, JC, ZR, ML – no conflict of interest.

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Epidemiology of Adolescent Trauma in England: a review of TARN data 2008-2017

Objectives

Trauma contributes significantly to adolescent morbidity and mortality. We aimed to ascertain the epidemiology of adolescent trauma to inform prevention strategies.

Methods

Data were abstracted from TARN (Trauma Audit Research Network) from English sites over a ten-year period (2008-2017). Adolescents were defined as 10-24 completed years. Descriptive statistical analysis was utilised in this study.

Results

There were 40,680 recorded cases of adolescent trauma. The majority were male (77.3%) and aged 16-24 years old (80%). There was a 2.6-fold increase during the study time frame (p<0.0001) in the total annual number of cases reported to TARN. To account for increasing hospital participation, the unit trauma cases per hospital per year was used, noting an increasing trend (p=0.048). Road traffic collision (RTC) was the leading cause of adolescent trauma (50.3%). Pedestrians (44.5%) and cyclists (29.9%) were more prevalent in the 10-15-year group, while drivers (22.7%) and passengers (17.4%) predominated in the 16-24-year-group.

Intentional injury was reported in 20.7% (alleged assault in 17.2% and suspected self-harm in 3.5%). This was more prevalent in the 16-24 year group. The proportion of trauma reported due to violence has increased with stablings increasing from 6.9% in 2008 to 10.2% in 2017 (p<0.0001). Evidence of alcohol or drug use was recorded in 20.1% of cases.
There was an increase in the number treated in MTCs (45.7% 2008 vs 63.4% 2017, p<0.0001). Trauma was more likely to occur between 08.00 and 00:00, at weekends and between April and October. Overall mortality rate was 4.1%. Those with a known psychiatric diagnosis had a higher mortality (6.3% vs 4.0%; p<0.001).

Conclusions
RTC and intentional injuries are leading aetiologies. Health care professionals and policy makers need to prioritise national preventative public health measures and early interventions to reduce the incidence of trauma in this vulnerable age group.
What this paper adds

What is already know on this subject

- After the first year of life, adolescence is the period when children and young people are most likely to die with the leading causes of adolescent mortality including risk taking behaviours and trauma.

- There are limited epidemiological studies specific to adolescent trauma and none which have accessed the TARN database in the UK.

- Epidemiology studies are required to inform the public and policy makers of current trends in adolescent trauma, allowing up to date evidence to be utilised to drive prevention campaigns.

What this paper adds

- Road traffic accidents are the most common cause of trauma in adolescents, followed by falls, blast/blows and stabbings.

- The overall proportion of trauma cases due to stabbing increased from 6.9% to 10.2% with a greater than three-fold increase in the number of reported stabbings per year.

- Evidence of alcohol or drug use was recorded at time of injury in 20.1% of adolescent trauma cases.
**Background**

After the first year of life, adolescence is the period when children and young people (CYP) are most likely to die, with almost 1300 deaths in the UK in 2014\(^1\). Adolescent mortality rates have decreased only minimally in the last 50 years, and to a lesser extent than most other age groups.\(^1\)

Adolescent medicine is a unique subspecialty encompassing paediatric and adult services. With no uniform age for transition, an adolescent trauma patient may receive treatment in a paediatric, adult or mixed trauma centre depending on their age and geographical location. Age, as the sole determinant is difficult, given the lack of consistency in the definition of an adolescent. The WHO (World Health Organisation) and UNICEF both define adolescent in terms of age as 10-19, with further definitions of youth being 15-24 and young people 10-24\(^2,3\). A recent international position paper, however, recommended the extended age range of 10 to 24 completed years in order to better acknowledge ‘recognised shifts in events of biological growth and social role transitions’\(^4\). This trend for extended age is gaining traction within the UK with the RCPCH supporting this change\(^5\). Internationally, the US youth violence prevention strategies are targeted for the 10-24 age bracket\(^6\).

With growing independence, there may be reduced self-control, increased risk-taking behaviours and experimentation with alcohol and drugs. Mental illness often presents during this time with suicide among the leading causes of death in young people\(^1\). Adolescence is therefore a key juncture at which to intervene positively with health promotion and preventative messages and measures.\(^7\)

With very little research published on the epidemiology of adolescent trauma, there are only a handful of papers providing any resources to drive prevention campaigns and legislation. Using population datasets can help inform this work and may decrease the relatively high morbidity and mortality that remains in this age group.
TARN (Trauma and Audit Research Network) is a UK based database collating trauma data from England, Wales and N. Ireland. No publication specific to the adolescent age group has been published utilising TARN data. We therefore aimed to interrogate these data to ascertain the current epidemiology of adolescent trauma in England using TARN data and explore patterns of change over a 10-year period.

**Methods**

TARN data for all trauma episodes, from English sites, over a ten-year period were included in this analysis (1st January 2008 to 31st December 2017). Pre-hospital deaths were excluded as these are not collected by TARN. Data is entered into TARN by the hospital research team retrospectively. For this research project, the analysis was run 17th April 2019. Polytrauma is defined as Abbreviated Injury Scale (AIS) 3+ in more than one body area.

The TARN database includes patients of any age who sustain injury resulting in: hospital admission > 3 days, intensive care admission, transfer to a tertiary/specialist centre or in-hospital death within 30 days. A patient can meet inclusion criteria with an ISS<15.

The study was limited to English sites as Wales and Northern Ireland started entering data at a later date. Scotland trauma data is captured by STAG (Scottish Trauma Audit Group) and so was not included in this analysis.

Adolescence was defined as 10-24.99 years and this was the age range of patient included in the analysis. The cohort was sub-categorised for analysis into 10-15 years and 16-24 years to reflect the current model of care in the UK; the younger cohort are usually managed in paediatric services, and the older cohort in adult services.
Abstracted data included age, gender, mechanism of injury (MOI), timing of injury, type of centre (Trauma Unit [TU] or level 2 trauma centre vs Major Trauma Centre [MTC] or level 1 trauma centre), injury severity score (ISS), number of operations, length of stay (LOS), mortality and total number of cases per calendar year. To account for the increasing hospital membership of TARN over the study period, trauma cases per hospital per year was utilised. Concurrent Hospital Episode Statistics (HES) data was also interrogated to identify hospitals whose data submission was consistent and in keeping with that expected for their population. These hospitals were defined as ‘consistent submitters’ and 34 were included for this analysis.

Continuous variables are displayed as median and interquartile range whereas categorical variables as number and percentage. Linear regression was used to analyse change in trauma cases over time. Pearson’s $\chi^2$ test to compare proportions was used for categorical variables, a chi square test goodness of fit for uniform distribution, Bonett-Price test to compare 2 medians for non-normally distributed data, and Kruskal-Wallis test for comparing 3 or more medians for continuous variables. The threshold for statistical significance was set at a $p$-value < 0.05. Data were analysed using the Stata V.14.2 (Stator). Stata Statistical Software: Release 14.2. College Station).

Subgroup analysis was performed on two specific variables; evidence of substance misuse and previous psychiatric history. Both are known risk factors for adolescent morbidity and mortality but their role in adolescent trauma is unclear. Outcomes (ISS, LOS, mortality) were compared for those with evidence of substance misuse and previous psychiatric history and those without.

TARN has ethical approval (PIAG section 60) for research on the anonymised data that are stored securely on the University of Manchester server.

**Patient and Public Involvement**
Retrospective data from the TARN database was used in this study, limiting the role of patient and public involvement in design, recruitment and conduct of this study. The research team plan to share the results with the relevant patient and public groups to inform prevention campaigns and education.

**Results**

*Demographics*

There were 40,680 trauma cases in total, 7,914 (19.5%) aged 10-15 years, and 32,766 (80.5%) aged 16-24 years (Table 1). There was a 2.6-fold increase in the total annual number of cases recorded by TARN during this time period. Over the study period, hospital TARN membership almost doubled, therefore this variation was expressed as trauma cases per hospital per year. This identified a low of 15.9 trauma cases per hospital per year in 2010 which increased to 21.52 in 2016 (Figure 1). Using linear regression an increasing trend was observed (p=0.048; Figure 1). In the consistent submitters group, a 2.3-fold increase in the total annual number of cases was noted during this time period (Appendix Figure 1).

The mean age for the overall study cohort was 19.2 years (SD 3.7 years). Males accounted for 78.7% (n=31,439), a pattern which was consistent when the cohort was divided into sub-groups by age (Table 1).
Table 1: Trauma cases reported to TARN, 10-24 years, England, 2008-2017, displayed by subgroup and total cohort

<table>
<thead>
<tr>
<th></th>
<th>10 -15</th>
<th>16 - 24</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>CASES</td>
<td>7914</td>
<td>32766</td>
<td>40680</td>
</tr>
<tr>
<td>Male n (%)</td>
<td>5647 (71.4%)</td>
<td>25792 (78.7%)</td>
<td>31439 (77.3%)</td>
</tr>
<tr>
<td>Female n (%)</td>
<td>2267 (28.6%)</td>
<td>6974 (21.3%)</td>
<td>9241 (22.7%)</td>
</tr>
<tr>
<td>Mean age (SD)</td>
<td>13.3 (1.70)</td>
<td>20.7 (2.5)</td>
<td>19.2 (3.7)</td>
</tr>
<tr>
<td>MECHANISM OF INJURY n (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RTC</td>
<td>3786 (47.8%)</td>
<td>16663 (50.9%)</td>
<td>20449 (50.3%)</td>
</tr>
<tr>
<td>Driver</td>
<td>44 (1.2%)</td>
<td>3811 (22.9%)</td>
<td>3855 (18.9%)</td>
</tr>
<tr>
<td>Passenger</td>
<td>402 (10.6%)</td>
<td>2956 (17.8%)</td>
<td>3358 (16.5%)</td>
</tr>
<tr>
<td>Pedestrian</td>
<td>1558 (41.2%)</td>
<td>2343 (14.1%)</td>
<td>3901 (19.1%)</td>
</tr>
<tr>
<td>Motorcyclist¹</td>
<td>412 (10.9%)</td>
<td>5390 (32.4%)</td>
<td>5802 (28.4%)</td>
</tr>
<tr>
<td>Cyclist</td>
<td>1234 (32.6%)</td>
<td>1486 (8.9%)</td>
<td>2720 (13.3%)</td>
</tr>
<tr>
<td>Other²</td>
<td>133 (3.5%)</td>
<td>644 (3.9%)</td>
<td>777 (3.8%)</td>
</tr>
<tr>
<td>Fall&gt;2m</td>
<td>895 (11.3%)</td>
<td>3798 (11.6%)</td>
<td>4693 (11.5%)</td>
</tr>
<tr>
<td>Fall&lt;2m</td>
<td>1775 (22.4%)</td>
<td>3247 (9.9%)</td>
<td>5022 (12.3%)</td>
</tr>
<tr>
<td>Shooting</td>
<td>38 (0.5%)</td>
<td>411 (1.3%)</td>
<td>449 (1.1%)</td>
</tr>
<tr>
<td>Stabbing</td>
<td>235 (3%)</td>
<td>2783 (8.5%)</td>
<td>3018 (7.4%)</td>
</tr>
<tr>
<td>Blast³/Blow(s)⁴</td>
<td>741 (9.4%)</td>
<td>4583 (14%)</td>
<td>5324 (13.1%)</td>
</tr>
<tr>
<td>Other³</td>
<td>450 (5.7%)</td>
<td>1286 (3.9%)</td>
<td>1736 (4.3%)</td>
</tr>
<tr>
<td>INJURY INTENT n (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alleged assault</td>
<td>418 (5.3%)</td>
<td>6569 (20.0%)</td>
<td>6987 (17.2%)</td>
</tr>
<tr>
<td>Suspected self-harm</td>
<td>202 (2.6%)</td>
<td>1235 (3.8%)</td>
<td>1437 (3.51%)</td>
</tr>
<tr>
<td>PMH PSYCH n (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>335 (4.2%)</td>
<td>2314 (7.1%)</td>
<td>2649 (6.5%)</td>
</tr>
<tr>
<td>EVIDENCE OF ALCOHOL/DRUG USE n (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alcohol</td>
<td>171 (2.2%)</td>
<td>6476 (19.8%)</td>
<td>6647 (16.3%)</td>
</tr>
</tbody>
</table>
### Drugs

<table>
<thead>
<tr>
<th>Drugs</th>
<th>52 (0.7%)</th>
<th>1497 (4.6%)</th>
<th>1549 (3.8%)</th>
</tr>
</thead>
</table>

### INJURIES n (%)

<table>
<thead>
<tr>
<th>Polytrauma</th>
<th>683 (10.5%)</th>
<th>5107 (15.5%)</th>
<th>6938 (17.1%)</th>
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</thead>
<tbody>
<tr>
<td>Isolated</td>
<td>7083 (89.5%)</td>
<td>26659 (81.4%)</td>
<td>33742 (82.9%)</td>
</tr>
</tbody>
</table>

### OUTCOME

<table>
<thead>
<tr>
<th>Died n (%)</th>
<th>234 (3.2%)</th>
<th>1346 (4.4%)</th>
<th>1580 (4.1%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rehab n (%)</td>
<td>2237 (28.3%)</td>
<td>10863 (33.2%)</td>
<td>13100 (32.2%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Median no of operations (IQR)</th>
<th>1 (1 - 1)</th>
<th>1 (1 - 2)</th>
<th>1 (1 - 2)</th>
</tr>
</thead>
</table>

### All forms of motored bike

2 Other includes pillion passengers, mass transport passengers, mobility scooter and unknown

3 Defined as an explosion

4 Defined as blunt contact e.g. punch/kick

5 Other includes crush injuries, burns, asphyxia, drowning, dog bites

6 Defined as Abbreviated Injury Scale (AIS) 3+ injuries in > 1 body area

### Timing of incident

The majority of trauma incidents occurred between 08:00 and 00:00 (76.6%) (Appendix Figure 2a). In the 10-15 year old group, 93.9% presented between 08:00 and 00:00, with only 6.1% presenting after midnight. In the 16-24 year old group, 72.5% presented between 08:00 and 00:00 and 27.5% after midnight (p<0.0001).

Patients were more likely to present to ED between Friday and Sunday, with 14.8% on Friday, 19.4% on Saturday and 18.6% on Sunday. This was most marked in 16-24 than 10-15 years old (54.1% versus 47.6%, p<0.0001) (Appendix Figure 2b). There was little variation between weekday
presentations (11.5%-12.4%). Most adolescent trauma (64.5%) presented between April and October, with a peak number of cases of 9.7% in May (Appendix Figure 2c).

Mechanism of Injury

Results regarding mechanism of injury (MOI) are displayed in Table 1 and Table 2. Involvement in a road traffic collision (RTC) was the most prevalent MOI overall (50.3%) and in both subgroups (47.8% of 10-15 years old and 50.9% of 16-24 years old, p<0.0001). On further analysis of RTC involvement by position in vehicle, differences emerged between the subgroups. In the 10-15-year group, pedestrians (41.2%) and cyclists (32.6%) predominated. In contrast, drivers (22.9%), motorcyclists (32.4%) and passengers (17.8%) were more prevalent in the 16-24-year group. Of note, 1.2% (n=44) of 10-15-year group were drivers.

Intentional injury was reported in 20.7% (n= 8,424), with 17.2% reporting alleged assault and 3.5% suspected self-harm. Both alleged assault and suspected self-harm were more prevalent in the 16-24 year group compared with the 10-15-years old (20.0% v 5.3%; p<0.0001 for assault and 3.8% v 2.6%; p<0.0001 for self-harm).

The overall proportion of trauma cases due to stabbing increased from 6.9% to 10.2% (2008 vs 2017; p<0.0001) with greater than three-fold increase in the number of reported stabbings per year (n=140 in 2008 vs n=544 in 2017; p<0.0001; Table 2, Figure 2). There was an increase in number of reported shootings although a decrease in overall proportion of trauma cases (1.4% (n=29) in 2008, 1.0% (n=56) in 2017; Table 2, Figure 2). Both stabbings and shootings were more prevalent in 16-24 years old compared with 10-15 years old (8.5% vs 3.0%; p<0.0001 and 1.3% vs 0.5%; p<0.0001 Table 1).
<table>
<thead>
<tr>
<th>Year</th>
<th>Blast</th>
<th>Blow(s)</th>
<th>Burn</th>
<th>Crush</th>
<th>Fall &lt;2m</th>
<th>Fall &gt;2m</th>
<th>Other</th>
<th>Shooting</th>
<th>Stabbing</th>
<th>RTC</th>
<th>Total</th>
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</thead>
<tbody>
<tr>
<td>2008</td>
<td>1(0.1)</td>
<td>254(12.5)</td>
<td>1(0.1)</td>
<td>8(0.4)</td>
<td>155(7.7)</td>
<td>238(11.8)</td>
<td>99(4.9)</td>
<td>29(1.4)</td>
<td>140(6.9)</td>
<td>1099(54.3)</td>
<td>2024</td>
</tr>
<tr>
<td>2009</td>
<td>6(0.2)</td>
<td>339(12.5)</td>
<td>4(0.1)</td>
<td>13(0.5)</td>
<td>272(10.0)</td>
<td>295(10.9)</td>
<td>119(4.4)</td>
<td>41(1.5)</td>
<td>193(7.1)</td>
<td>1425(52.6)</td>
<td>2707</td>
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<tr>
<td>2010</td>
<td>10(0.3)</td>
<td>481(14.5)</td>
<td>5(0.2)</td>
<td>39(1.2)</td>
<td>312(9.4)</td>
<td>436(13.2)</td>
<td>160(4.8)</td>
<td>52(1.6)</td>
<td>225(6.8)</td>
<td>1594(48.0)</td>
<td>3314</td>
</tr>
<tr>
<td>2011</td>
<td>13(0.3)</td>
<td>655(15.5)</td>
<td>3(0.1)</td>
<td>50(1.2)</td>
<td>498(11.8)</td>
<td>490(11.6)</td>
<td>121(2.9)</td>
<td>53(1.3)</td>
<td>308(7.3)</td>
<td>2030(48.0)</td>
<td>4221</td>
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<tr>
<td>2012</td>
<td>5(0.1)</td>
<td>634(14.3)</td>
<td>6(0.1)</td>
<td>51(1.2)</td>
<td>577(13.0)</td>
<td>511(11.6)</td>
<td>129(2.9)</td>
<td>40(0.9)</td>
<td>264(6.0)</td>
<td>2207(49.9)</td>
<td>4424</td>
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<tr>
<td>2013</td>
<td>3(0.1)</td>
<td>538(12.2)</td>
<td>3(0.1)</td>
<td>40(0.9)</td>
<td>607(13.7)</td>
<td>508(11.5)</td>
<td>156(3.5)</td>
<td>40(0.9)</td>
<td>282(6.4)</td>
<td>2241(50.7)</td>
<td>4418</td>
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<tr>
<td>2014</td>
<td>3(0.1)</td>
<td>516(11.5)</td>
<td>9(0.2)</td>
<td>34(0.8)</td>
<td>624(14.0)</td>
<td>518(11.6)</td>
<td>137(3.1)</td>
<td>35(0.8)</td>
<td>260(5.8)</td>
<td>2337(52.2)</td>
<td>4473</td>
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<tr>
<td>2015</td>
<td>2(0.0)</td>
<td>597(12.3)</td>
<td>8(0.2)</td>
<td>44(0.9)</td>
<td>658(13.6)</td>
<td>538(11.1)</td>
<td>132(2.7)</td>
<td>46(1.0)</td>
<td>369(7.6)</td>
<td>2448(50.6)</td>
<td>4842</td>
</tr>
<tr>
<td>2016</td>
<td>9(0.2)</td>
<td>612(12.4)</td>
<td>4(0.1)</td>
<td>38(0.8)</td>
<td>633(12.9)</td>
<td>547(11.1)</td>
<td>118(2.4)</td>
<td>57(1.2)</td>
<td>433(8.8)</td>
<td>2471(50.2)</td>
<td>4922</td>
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<tr>
<td>2017</td>
<td>21(0.4)</td>
<td>625(11.7)</td>
<td>6(0.1)</td>
<td>27(0.5)</td>
<td>686(12.9)</td>
<td>612(11.5)</td>
<td>172(3.2)</td>
<td>56(1.0)</td>
<td>544(10.2)</td>
<td>2586(48.5)</td>
<td>5335</td>
</tr>
</tbody>
</table>

Table 2: Trauma cases reported to TARN by mechanism of injury, 10-24 years, England, 2008-2017, n(%)
MTC vs TU
Overall, 57.4% (n=23,361) presented to a Major Trauma Centre (MTC) and 42.6% (n=17,319) to a Trauma Unit. Figure 3 shows the increasing number of trauma cases attending MTCs each year. The overall proportion of cases attending MTCs increased from 45.7% in 2008 to 63.5% in 2017 (p<0.0001).

Morbidity and mortality
Isolated injuries were reported in 82.9% (n=33,742) with 17.1% (n=6,938) sustaining polytrauma (Table 1). Median number of operations was 1. Median length of stay in hospital was 6 days (IQR 4-9 days) for 10-15-years old and 6 days (IQR 4-12 days) for 16-24-years old. Rehabilitation was required in 32.2% (n=13,100).

From 2008-2017, there were 1,580 (4.1%) adolescent trauma-related deaths. Mortality was higher in the 16-24 year old group, with 1,346 (4.4%) deaths recorded compared with 234 (3.2%) deaths in 10-15 year old group.

Past medical history
‘No previous medical conditions’ were reported in 61.7%. The most prevalent conditions for the cohort were respiratory (6.4%), psychiatric (6.5%) and substance misuse (2.6%). For the 10-15 year group, the most prevalent conditions remained respiratory (6.9%), psychiatric (4.2%) followed by neurological (2.6%). In the 16-24-years old, psychiatric conditions and respiratory were the most prevalent (7.1% and 6.3 respectively), followed by substance misuse (3.1%) - (Appendix Table 1).

Psychiatric history
Analysis of the impact of pre-existing mental health conditions found there was statistically significant difference in age (psychiatric history 20.6years vs no psychiatric history 19.7 years; p<0.0001) and in ISS (psychiatric history 13 vs no psychiatric history 10; p<0.0001, Table 5). There was a statistically significant difference in mortality, which was higher in those with a previous
psychiatric history (psychiatric history 6.3% vs no psychiatric history 4.4%; p<0.0001, Table 3).

Evidence of substance misuse

Evidence of alcohol or drug use was recorded at time of injury in 20.1% (n=8,196) (Table 1). This was most notable in the 16-24 year group (19.8% having evidence of alcohol use and 4.6% evidence of drug vs 2.2% and 0.7% of 10-15 year old group, respectively). Those who had ingested alcohol or drugs had a statistically significantly higher median ISS (ingestion 14 v no ingestion 10; p<0.0001, Appendix Table 5). There was a statistically significant difference in mortality, which was lower in those who had ingested alcohol or drugs (ingestion mortality 2.6% vs no ingestion 4.2%; p<0.0001, Appendix Table 2).

Discussion

This paper describes for the first time the epidemiology of adolescent trauma in England. It provides a unique viewpoint on trauma over the extended age range from 10-24 years, that is in keeping with the most recent definition of adolescence. It compliments work analysing trauma patterns in children and adults which may predominantly focus on younger children and the elderly. It sets out the increase in reported incidence and the changes in injury patterns both over time and between younger and older adolescents. It also highlights a troubling correlation between psychiatric co-morbidity and increased mortality. It should provide guidance for policy makers both nationally and internationally to guide much needed future prevention strategies.

Over the period studied, there was an increase in the overall annual incidence of adolescent trauma including in the consistent submitters cohort. This increase is at least in part down to improved recording practice. However, given that the increase is seen across hospitals that reported consistently against their predicted cases using HES data, consideration has to be given
to the possibility of a true increase in the incidence of adolescent trauma. This potential increase in trauma incidence is seen at a time in which the total number of young people in the UK actually reduced by 2% while overall UK ED attendance in this age group rose by 5% between 2012/13 and 2017/18\textsuperscript{12,13}. This increase in recorded trauma is also seen in contrast to international data. In the US, where trauma reporting processes have been more stable, an 8.3% reduction in injury related presentations was noted between 2006-2012\textsuperscript{14}. Similarly, there has been no increase in reported paediatric major trauma in recently reported data from Australia\textsuperscript{15}.

The paper describes a male predominance in adolescent trauma presentations and an increasing incidence with age. It confirms the seasonal and day specific variation seen in adult and paediatric trauma with adolescent trauma more common in summer months and at weekends\textsuperscript{16,17}. Timing of injury noted 6.1% of younger adolescents (10-15 years old) presenting between midnight and 8 a.m. as opposed to 27.5% of those aged 16-24 years. This has a direct impact on staffing models of Major Trauma Centres and supports current practice of non-resident consultant working overnight in units only caring for those under 16.

Road traffic collisions (RTC) were consistently the leading cause of trauma in adolescents across the study period accounting for 50.3% of all cases. This comes at a time of rising vehicle safety standards and increased public health measures, such as the introduction of 20mph speed limits. There was variation between the adolescent sub-groups in how they were injured in RTC’s, suggesting the need for tailored prevention campaigns. A higher proportion were passengers in the 16-24 year group, potentially reflecting the dangers of young drivers transporting friends. Recommendations for a graduated driver’s license and who they transport may have merit\textsuperscript{18,19}.

We note with concern the increase in the proportion of presentations related to violence, in particular the increase in reported stabbings with the incidence more than doubling between 2014 and 2017. This corroborates both UK police and hospital data which has shown recent year on year rises in crimes and injuries related to knives and sharp objects of 16 and 14% respectively\textsuperscript{20}. This
holds a particular relevance to paediatric emergency departments (PED), which traditionally had low numbers of stabbings. The increase re-enforces the need for PED’s to ensure trauma skills are maintained and to have a working knowledge of the legislation regarding reporting of stabbings. The increase in stabbings is most likely multifaceted but may be contributed to by an increase in gang related violence in urban areas. Further research is required to confirm this and we note that the UK government does not publish data on reported gang membership\(^{21}\). We would urge politicians and legislators as well as professionals working in health and education to commit appropriate resource to address this concerning increase.

During the 10-year study period mortality was reported as 4.1%. This however is likely to be an underestimation of true mortality from adolescent trauma as it only records those who die after reaching hospital and not those that die at the scene. While there is no directly comparable data, the number of adolescents dying from trauma may be significantly higher with 1,334 deaths attributed to external causes (also includes poisoning) in England and Wales in 2015 alone\(^{22}\).

Sub-group analysis highlighted the impact of a pre-existing psychiatric diagnosis and the use of alcohol or drugs on adolescent trauma. Those with a known psychiatric diagnosis had a higher ISS and mortality when compared to those without but this may be a skewed sample given the data base that was interrogated. However, other studies would support this\(^ {23,24}\). Targeted intervention in this ‘at-risk’ group would be warranted. Alcohol and drugs had a role in 20.1% of cases. This would appear lower than that described in the US (21-34% of adolescent trauma patients\(^ {25,26}\)). Although cases involving alcohol and drugs had a higher ISS compared to those without, the opposite was true for mortality, being lower in those who consumed alcohol or drugs. We are unable to explain this finding which is contrary to US data\(^ {27}\) and needs further research to help understand its significance.

The paper reflects the changes in practice seen in national trauma management in England since the inception of the major trauma networks with the increased numbers seen in MTCs indicating adherence to the trauma
bypass process. Parallel work now needs to be undertaken to ascertain whether this has led to improvements in morbidity and mortality for this cohort. There is a mixed national picture of provision between adult, paediatric and mixed major trauma centres, with variable age cut offs within these services. Further questions need to be asked about where care is best delivered and if there even needs to be consideration of adolescent emergency medicine as an entity in its own right.

Limitations

This study used data from England only and may not be generalisable over the whole of United Kingdom or internationally. The quality of data from trauma registries is reliant on the quality of data submitted by participating units. The dataset only included those cases that met TARN inclusion criteria. Therefore, cases that died at scene or had injuries that did not meet TARN inclusion criteria were not included in this analysis. Population changes in England did not form part of this analysis which may have impacted on the reported increase in overall trauma and in trauma cases secondary to violence. The data was sub-dived pragmatically into 10-15 and 16-24 years old given the current service delivery of care in the UK. This sub-classification may limit application of these results to international audiences. Finally, we acknowledge the challenge in comparing this data with that previously reported in the UK and internationally due to the differing definitions of an adolescent and the different patterns of injury seen, particularly with the US. We hope that the now accepted age definition of 10-24 years will make future comparative work easier and more reliable.

Conclusions

The incidence of recorded trauma in England in those aged 10-24 years has increased significantly over the last decade and there has been a concurrent rise in the number of those treated in major trauma centres. This is likely in part due to improved reporting practice and increased TARN hospital membership but the possibly of a true increase cannot be excluded. There is
a summer and weekend predominance in presentations with a considerable proportion of cases reporting alcohol or drug ingestion. While the majority were involved in road traffic collisions the proportion of stabbings has increased. Those with psychiatric comorbidities have a poorer outcome. This paper reminds health care professionals and policy makers of the potential importance of preventative public health measures and early interventions in these at-risk groups to reduce the incidence of trauma in this vulnerable age group.

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Ethical approval statement

TARN has ethical approval (PIAG section 60) for research using anonymised data that are stored securely on the University of Manchester server. Ethics approval:TARN holds HRA CAG section 251 approval for research on anonymised data submitted by member hospitals

Clinical Trial Registration

Clinical Trial Registration- Not applicable
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SM planned the study, was an author and reviewed manuscript. ZR was an author and reviewed manuscript. JAC was an author and reviewed manuscript. DJ was an author and reviewed manuscript. OB collated the results and reviewed manuscript. MY collated the results and reviewed manuscript. ML was an author and reviewed manuscript. DR was an author and reviewed manuscript.