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Victimisation, self-harm and drug or alcohol misuse in adolescents admitted to hospitals in England for injury: a retrospective cohort study

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5 1 **Victimisation, self-harm and drug or alcohol misuse in**
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8 2 **adolescents admitted to hospitals in England for injury: a**
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10 3 **retrospective cohort study**
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56 **ABSTRACT**7
8 **Objectives**

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10 Of adolescents in the general population in England, we aimed to determine
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12 1) the proportion that has an emergency admission to hospital for injury
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14 related to adversity (victimisation, self-harm or drug or alcohol misuse) and 2)
15
16 the risk of recurrent emergency admissions for injury in adolescents admitted
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18 with adversity-related injury compared with those admitted with accident-
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20 related injury only.
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23 **Design**

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25 We used hospital administrative data (Hospital Episode Statistics) to identify
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27 10-19 year olds with emergency admissions for injury in England in 1998-
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29 2011. We used Office for National Statistics mid-year estimates for
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31 population denominators.
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34 **Results**

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36 Approximately 4.3% of adolescents in the general population had one or more
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38 emergency admissions for adversity-related injury (140 512/3 254 046; girls
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40 4.6%, boys 4.1%), accounting for 59.9% of all emergency admissions for
41
42 injury in girls and 29.6% in boys. Admissions for self-harm or drug or alcohol
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44 misuse commonly occurred in the same girls and boys. Recurrent emergency
45
46 admissions for injury were more common in adolescents with adversity-
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48 related injury (girls 17%; boys 17%) than in those with accident-related injury
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50 only (girls 5%; boys 7%), particularly for adolescents with adversity-related
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52 injury related to multiple types of adversity (girls 21%; boys 24%).
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57 **Conclusion**58
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49 Hospital-based interventions should be developed to reduce the risk of future
50 injury in adolescents admitted for adversity-related injury.

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3 51 **What is already known on this subject**
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- 5 52 • Adolescents exposed to adversity (victimisation, self-harm or drug or
6 alcohol misuse) often use health services, and repetitively.
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9 54 • Many adolescents in the general population are exposed to multiple
10 types of adversity during their adolescence.
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17 57 **What this study adds**

- 18 58 • One in 20 adolescents in England have an emergency admission to
19 hospital for adversity-related injury between 10 and 19 years old.
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22 60 • Many adolescents admitted with adversity-related injury (particularly
23 girls) are admitted with multiple types of adversity, self-harm and drug
24 or alcohol misuse being the most common combination.
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29 63 • Readmission is more common in these adolescents than those
30 admitted with accident-related injury only.
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37 66 **Strengths and limitations of this study**

- 38 67 • Hospital Episodes Statistics (HES) captured data on all admissions to
39 National Health Service hospitals in England at 10-19 years old in this
40 study's cohort.
41 68
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45 70 • The longitudinal link between admissions for each individual in HES
46 data allowed us to study the burden of multiple emergency admissions
47 for injury over time.
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52 73 • However, victimisation, self-harm and drug or alcohol misuse are not
53 always recognised at an admission, or consistently recorded, and
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75 therefore this study's estimates of prevalence of adversity are likely to
76 be underestimates.

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77 INTRODUCTION

78 Many adolescents exposed to adversity such as victimisation (maltreatment or
79 assault), self-harm, or drug or alcohol misuse use secondary health
80 services,[1 2] often repetitively.[3 4] For example, in a self-report survey of
81 15-16 year olds in England, 12.6% of those who had self-harmed had
82 presented to hospital.[2] It is also estimated that approximately one-third of
83 patients attending a hospital in England for self-harm re-attend for self-harm in
84 the following year.[4] Improved management of adolescents exposed to
85 adversity could reduce risk of repetition as well as the burden on secondary
86 care.[5-7]

87 An admission to hospital provides the 'teachable moment',[8] where
88 both adolescents and their families may be more likely to engage an
89 intervention than if they had received it elsewhere. Hospital-based
90 interventions to reduce the risk of future harm could benefit these adolescents
91 by reducing episodes of injury, and may reduce recurrent emergency (i.e.,
92 acute or unplanned) admissions for injury.

93 To-date, there is a lack of evidence on how different types of adversity
94 related injury occur in the same adolescents, over time. In addition, policy
95 makers and service providers need know how many adolescents have an
96 emergency admission to hospital for adversity-related injury, their
97 characteristics and their specific rates of re-admission if they are to be
98 feasibly targeted for intervention.

99 In this study we used administrative hospital data and Office for
100 National Statistics (ONS) mid-year population estimates to estimate the
101 number of adolescents in the general population who ever have an

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3 102 emergency admission to hospital for injury. We then estimated the
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5 103 prevalence of emergency admissions for injury related to victimisation, self-
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7 104 harm and drug or alcohol misuse (alone and co-occurring) in the general
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9 105 population. Finally we determined the risk of recurrent emergency admissions
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11 106 for injury in adolescents who had at least one admission between 10 and 19
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13 107 years for adversity-related injury compared with adolescents only ever
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15 108 admitted for accidental injury during the same period.
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5 109 **METHODS**
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8 110 **Study population**
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10 111 Using administrative data from all admissions to National Health Service
11 hospitals in England (Hospital Episode Statistics [HES]) in 1998-2011,[9] we
12 derived a retrospective cohort of adolescents who turned 10 years old in
13 1998-2002, who could be observed throughout adolescence until 19 years old
14 (Supplementary Table 1).[10] Each individual also had to have at least one
15 emergency admission for injury between 10 and 19 years old.
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24 117 **Admission data**
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26 118 The Health and Social Care Information Centre provided pseudonymised data
27 on hospital admissions, use of which did not require Research Ethics
28 Committee approval.[11] We analysed any hospital transfers or admissions
29 within one day after discharge as the same admission, as previously
30 described.[12] We used the variable for method of admission ('admimeth') to
31 define an emergency admission. We used all International Classification of
32 Diseases-10 (ICD-10) diagnosis codes recorded during an admission to
33 categorise admissions as being for injury related to adversity, an accident or
34 other causes (Supplementary Table 2).[13]
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47 127 **Types of injury and age at emergency admission**
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49 128 We defined an emergency admission for injury as being for related to
50 adversity, comprising victimisation (maltreatment/assault), self-harm or drug
51 or alcohol misuse, using mutually exclusive clusters of ICD-10 codes
52 (Supplementary Table 2). Victimisation was defined by previously validated
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3 132 codes, which would trigger consideration of maltreatment by carers or of
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5 133 assault.[12 14 15] We defined self-harm using codes that mentioned either
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7 134 'self-harm' or 'self-poisoning', and excluded 'undetermined intent'. Drug or
8
9 135 alcohol misuse was defined by codes that mentioned 'alcohol', 'drugs',
10
11 136 'noxious substance' or 'solvent'. We considered alcohol use (Z72.1) to be
12
13 137 misuse only in adolescents younger than 18. We defined an injury as being
14
15 138 related to accidents only if no adversity codes were present but there were
16
17 139 codes from the ICD-10 *Accidents* subchapter (V01-X59).[13]

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21 We grouped age at each admission as 10-14 years, 15-17 years and
22
23 141 18-19 years, to reflect age of onset of puberty (10-14 years), age of sitting
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25 142 secondary school exams (15-18 years) and the legal age for buying alcohol
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27 143 (18 years).[16-19]

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31 **144 Classification of adolescents according to types of injury and age at**
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33 **145 emergency admissions**

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35 146 We classed adolescents into groups according to all of their emergency
36
37 147 admissions for injury between 10 and 19 years old. Adolescents were
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39 148 classed as belonging to the 'AdvRI' group (any adversity-related injury
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41 149 between 10 and 19 years old), 'AccRI Only' group (no adversity-related injury
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43 150 but one or more accident-related injuries) or 'Other Causes' group (no
44
45 151 adversity-related or accident-related injuries) (Supplementary Figure 1).

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47 152 Among adolescents in the AdvRI group, we determined the proportion
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49 153 exposed to victimisation-, self-harm- and drug or alcohol misuse-related injury
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51 154 at age 10-19, respectively. We further classified the AdvRI group into seven
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53 155 mutually exclusive sub-groups: Victimisation Only, Self-harm Only, Drug or
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55 156 Alcohol Misuse Only (DA Only), Victimisation and Self-harm (V+SH),
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3 157 Victimization and Drug or Alcohol Misuse (V+DA), Self-harm and Drug or
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5 158 Alcohol Misuse (SH+ DA) and Victimization, Self-harm and Drug or Alcohol
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7 159 Misuse (V+SH+DA).
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10 160 We also grouped adolescents as above, according to their emergency
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12 161 admissions for injury at 10-14 years only, 15-17 years only and 18-19 years
13
14 162 only (Supplementary Figure 2).
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163 **Defining an adolescent as having a chronic condition**

164 We used a previously validated cluster of ICD-10 codes to identify
165 adolescents who had been affected by a chronic condition in any admission
166 between 10 and 19 years old (Supplementary Table 2).
17

167 **Population denominators**

168 We used ONS mid-year population estimates to derive population
169 denominators.[20 21] These data are freely available online broken down by
170 sex and year of age.
17

171 **Analyses**

172 We estimated the proportion of adolescents in the general population who had
173 an emergency admission for injury between 10 and 19 years old, by using the
174 number of adolescents in our derived retrospective cohort as the numerator
175 and ONS mid-year estimates for 10 year olds in 1998-2002 as the population
176 denominator. We then calculated these proportions by types of injury at 10-
177 19 years old (adversity-related [AdvRI group and seven mutually exclusive
178 subgroups] and accidents only [AccRI Only group]) and by age group, as
179 described above.
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3 180 We calculated the proportion of adolescents in the AdvRI group (and
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5 181 subgroups) and in the AccRI Only group, who had an emergency admission
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7 182 for injury twice and three or more times between 10 and 19 years old. We
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10 183 also calculated the proportions of adolescents with two or three or more
11
12 184 admissions of any type (including non-emergency and non-injury).

13
14 185 We reported all results separately for girls and boys, since differences
15
16 186 between girls and boys have been reported for prevalence of adversity in the
17
18 187 general population.[1 22-24] We calculated 95% confidence intervals for all
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21 188 proportions but did not present them as they were all too narrow to convey
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23 189 any useful information (within one unit of the sample estimate). Analyses
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25 190 were carried out in StataSE 12.
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5 191 **RESULTS**
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7 192 There were 1 033 702 adolescents in HES admissions data in 1998-2011, of
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9 193 which 402 916 formed the study cohort (462 476 emergency admission for
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11 194 injury, 802 682 admissions of any type [including non-emergency and non-
12
13 195 injury]) (Table 1), representing 12.4% (402 916/3 254 046) of the adolescent
14
15 196 population. Twice as many boys as girls had an emergency admission for
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17 197 injury during adolescence (144 158/1 588 942 girls in the population [8.7%];
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19 198 258 503/1 665 104 boys [16.3%]).
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199 **Table 1.** Characteristics of adolescents* between 10 and 19 years old

Characteristics	Adolescent Population†	Adolescents with emergency admission(s) for injury between 10 and 19 years old, n (row %)			
	Total	Total	AdvRI	AccRI Only	Other Causes
All	3,254,046	402,916 (100.0)	140,512 (34.9)	234,665 (58.2)	27,739 (6.9)
Age**					
Girls	1,588,942	144,158 (100.0)	72,768 (50.5)	59,528 (41.3)	11,862 (8.2)
10-14 years	.	65,208 (100.0)	23,289 (35.7)	37,303 (57.2)	4,616 (7.1)
15-17 years	.	48,286 (100.0)	31,620 (65.5)	12,882 (26.7)	3,784 (7.8)
18-19 years	.	30,664 (100.0)	17,859 (58.2)	9,343 (30.5)	3,462 (11.3)
Boys	1,665,104	258,503 (100.0)	67,704 (26.2)	174,962 (67.7)	15,837 (6.1)
10-14 years	.	121,821 (100.0)	17,660 (14.5)	97,511 (80.0)	6,650 (5.5)
15-17 years	.	79,223 (100.0)	25,004 (31.6)	49,366 (62.3)	4,853 (6.1)
18-19 years	.	57,459 (100.0)	25,040 (43.6)	28,085 (48.9)	4,334 (7.5)
Missing (Sex)	.	255 (100.0)	40 (15.7)	175 (68.6)	40 (15.7)
		Adolescents with emergency admission(s) for injury between 10 and 19 years old, n (column %)			
		Total	AdvRI	AccRI Only	Other Causes
All	3,254,046	402,916 (100.0)	140,512 (100.0)	234,665 (100.0)	27,739 (100.0)
Chronic Condition	.	117,190 (29.0)	47,001 (33.4)	52,509 (22.4)	16,706 (60.0)

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7 200 AdvRI = Adversity-related Injury, AccRI Only = Accident-related Injury Only.
8 201 *Adolescents whose entire ten years of adolescence (ages 10-19) occurred in 1998-2011.
9 202 †Based on ONS mid-year England statistics for 10 year olds in 1998-2002.[20]
10 203 **At first emergency admission for injury
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204 **Types of injury and age at emergency admission**

205 One-third of the cohort (140 152, 4.3% of the population) had a record of an
206 emergency admission for adversity-related injury between 10 and 19 years
207 old (the AdvRI group; 153 633 emergency admissions for adversity-related
208 injury) (Table 1), with similar rates between sexes (72 768, 4.3% girls in the
209 population; 67 704, 4.1% boys).

210 The remaining two-thirds of the cohort (262 404, 8.1% of the
211 adolescent population) had emergency admissions for injury which were
212 never related to adversity (Table 1). Among these adolescents, 234 665
213 (89.4%) had an accident-related injury (the AccRI Only group, 7.2% of the
214 population) and 27 739 (10.6%) had no accident-related injury (Other Causes
215 group, 0.9% of the population). A higher proportion of the Other Causes
216 group were affected by a chronic condition between 10 and 19 years old (16
217 706/27 739, 60%), compared with the AdvRI group (47 001/140 512, 33%) or
218 AccRI Only group (52 509/234 665, 22%).

219 These groupings (AdvRI [and subgroups], AccRI, Other Causes) are
220 provided in Supplementary Table 3, as proportions of adolescents in the
221 general population and within individual age groups.

222 **Types of adversity-related injury**

223 Among adolescents in the AdvRI group (girls 72 768, boys 67,704) (Figure 1),
224 the most common type of adversity was drug or alcohol misuse (girls 91.1%,
225 boys 58.0%). A higher proportion of boys than girls were exposed to
226 victimisation (girls 17.5%, boys 51.7%), but a higher proportion of girls than
227 boys were exposed to self-harm (girls 74.6%; boys 31.0%).

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3 228 Girls in the AdvRI group were most likely to be exposed to multiple
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5 229 types of adversity between 10 and 19 years old (73.6%) (Figure 1), especially
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7 230 SH+DA (61.7%, i.e., most of the 73.6%). Fewer boys in the AdvRI group
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9 231 were exposed to multiple types of adversity (36.2%), the most common
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11 232 combination also being SH+DA (22.7%).
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14 233 For most of the adolescents who exposed to multiple types of
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16 234 adversity, the combination of types was recorded at the same admission. For
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18 235 example, among the 352 adolescent girls who were exposed to victimisation
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20 236 and self-harm between 10 and 19 years old (Figure 1), 85.3% had both
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22 237 victimisation and self-harm codes present simultaneously at at least one
23
24 238 emergency admission for injury (V+DA 86.1%, SH+ DA 99.7%, V+ SH+ DA
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26 239 83.2%; boys: V+SH 63.2%, V+DA 84.5%, SH+DA 99.0%, V+SH+DA 59.1%)
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29 240 (data not shown).
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32 241 **Emergency readmissions for injury**

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34 242 Adolescent girls in the AdvRI group (50.5% of all girls in the cohort) accounted
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36 243 for 59.9% of the total number of emergency admissions for injury coming from
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38 244 girls (data not shown), compared with girls in the AccRI Only group (41.3% of
39
40 245 all girls) who accounted for 15.1%. Boys in the AdvRI group (26.2% of all
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42 246 boys in the cohort) accounted for 29.6% compared with 61.7% contributed by
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44 247 boys in the AccRI Only group (67.7% of all boys).
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48 248 More adolescents in the AdvRI group were readmitted for injury (i.e.,
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50 249 had two or more emergency admissions for injury) between 10 and 19 years
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52 250 old (both girls and boys 17%) (Figure 2), than in the AccRI Only group (girls
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54 251 5%; boys 7%). Among adolescents admitted for AdvRIs related to multiple
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252 types of adversity (Table 2), the proportion readmitted was even higher
253 (multiple types: girls 21%, boys 24%; single type: girls 7%, boys 12%).

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254 **Table 2.** Proportion of adolescent girls and boys with 1, 2 or 3+ emergency admission(s) for injury or 1, 2 or 3+ admissions of any
 255 type, by types of adversity between 10 and 19 years old*

Adolescent group*	No. girls	Girls (%)						No. boys	Boys (%)					
		Emergency admission(s) for injury			Admission(s) of any type				Emergency admission(s) for injury			Admission(s) of any type		
		1	2	3+	1	2	3+		1	2	3+	1	2	3+
All	144,158	88.6	8.3	3.1	57.6	20.5	22.0	258,503	90.3	8.0	1.8	68.5	18.7	12.9
AdvRI	72,768	82.6	12.0	5.3	53.8	21.0	25.2	67,704	83.4	12.5	4.1	64.7	19.4	15.9
Any V	12,710	73.1	15.7	11.2	46.7	21.0	32.3	35,003	82.6	12.9	4.5	64.9	19.4	15.7
Any SH	54,315	79.3	13.9	6.8	51.2	21.5	27.3	21,087	76.7	15.8	7.5	57.0	20.7	22.3
Any DA	66,255	81.8	12.5	5.7	53.5	21.1	25.4	39,264	80.9	13.7	5.4	62.6	19.6	17.8
Single adversity	19,194	92.9	6.1	1.0	61.2	19.6	19.2	43,214	87.6	10.2	2.2	68.5	18.8	12.8
V Only	4,047	91.8	6.7	1.5	57.6	20.2	22.2	25,908	87.0	10.7	2.3	68.1	19.2	12.7
SH Only	2,114	90.8	7.7	1.5	54.4	20.8	24.8	2,188	87.6	10.0	2.4	62.8	19.6	17.6
DA Only	13,033	93.5	5.7	0.8	63.4	19.3	17.3	15,118	88.5	9.4	2.1	69.9	17.9	12.2

Adolescent group*	No. girls	Girls (%)						Boys (%)						
		Emergency admission(s) for injury			Admission(s) of any type			Emergency admission(s) for injury			Admission(s) of any type			
		1	2	3+	1	2	3+	No. boys	1	2	3+	1	2	3+
Multiple adversity	53,574	79.0	14.2	6.9	51.1	21.5	27.3	24,490	76.1	16.5	7.5	58.0	20.7	21.4
V + SH	352	80.4	14.8	4.8	49.7	23.0	27.3	344	71.8	21.8	6.4	53.8	24.4	21.8
V + DA	1,373	84.6	13.0	2.3	54.0	22.4	23.6	5,591	78.3	16.4	5.3	63.4	20.1	16.5
SH + DA	44,911	81.8	13.1	5.1	52.9	21.6	25.5	15,395	79.7	14.8	5.5	59.1	21.0	19.8
V + SH + DA	6,938	59.5	21.5	19.0	38.7	21.2	40.2	3,160	54.8	24.2	21.0	43.0	19.5	37.4
No adversity	71,390	94.7	4.5	0.8	61.4	19.9	18.7	190,799	92.7	6.4	0.9	69.8	18.4	11.8
AccRI Only	59,528	95.3	4.1	0.6	66.6	18.7	14.7	174,962	92.6	6.5	0.9	71.4	18.1	10.5
Other Causes	11,862	91.6	6.3	2.1	35.4	25.8	38.7	15,837	93.4	5.0	1.6	51.7	22.1	26.2

256 V = Victimisation, SH = Self-harm, DA = Drug or Alcohol Misuse, AdvRI = Adversity-related Injury, AccRI Only = Accident-related
 257 Injury Only.
 258 * Each adolescent classified by all adversities/accidents seen at any emergency admission(s) for injury between 10 and 19 years
 259 old.

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3 260 Similarly, a higher proportion of adolescents in the AdvRI group had
4
5 261 two more admissions of any type (including non-emergency and non-injury)
6
7 262 between 10 and 19 years old (girls 36.2%; boys 35.3%; Table 2) compared
8
9 263 with adolescents in the AccRI Only group (girls 33.4%; boys 28.6%). This
10
11 264 proportion was even higher for adolescents in the AdvRI group who were
12
13 265 admitted with multiple types of adversity (multiple types: girls 48.8%, boys
14
15 266 42.1%; single type: girls 38.8%, boys 31.6%).
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3 267 **DISCUSSION**

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5 268 More than one in 20 adolescents in England had at least one emergency
6
7 269 admission for adversity-related injury between 10 and 19 years old. These
8
9 270 adolescents accounted for a third of all adolescents with emergency
10
11 271 admissions for injury and for a disproportionate number of re-admissions for
12
13 272 injury, particularly adolescents admitted with multiple types of adversity-
14
15 273 related injury. Targeting adolescents admitted with adversity-related injury
16
17 274 could reduce their risk of future harm and the rate of re-admissions to
18
19 275 hospital, which are some of the most expensive types of healthcare and the
20
21 276 UK government is keen to reduce.[25]

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24
25 277 Longitudinally-linked admissions allowed us to study the entire ten
26
27 278 years of adolescence in 402 916 adolescents, to distinguish between types of
28
29 279 adversity that co-occurred during adolescence or at the same admission, and
30
31 280 to study re-admissions.

32
33
34 281 One weakness of this study was our reliance on diagnostic codes
35
36 282 recorded in administrative data. Maltreatment and drug or alcohol misuse
37
38 283 have been shown to be under-recorded using ICD-10,[26 27] but false
39
40 284 positives are rare.[15] To address under-recording, we used what we
41
42 285 considered to be sensitive clusters of codes for adversity. Other factors
43
44 286 related to recording or coding practices,[12 14 15 27 28] for example, new
45
46 287 guidelines for defining maltreatment,[14] can also affect ascertainment.
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48 288 Because of the relative insensitivity but good specificity of the coding clusters,
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50 289 some adolescents who were classified in the AccRI group may in fact belong
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52 290 to the AdvRI group, but did not have their adversity recognised or recorded.
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54 291 Consequently, our prevalence estimates of admission for different types of
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3 292 adversity-related injury are likely to provide a lower bound for the true
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5 293 prevalence.

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7 294 Our prevalence estimates of admission for injury related to individual
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9 295 types of adversity from the general adolescent population are consistent with
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11 296 previous reports for emergency admissions for assault-related injury in 2004-
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13 297 2009 and for all admissions (emergency and non-emergency) for self-harm
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15 298 and drug or alcohol misuse.[1 2 24 29] Previous studies have reported higher
16
17 299 rates of drug or alcohol misuse in boys than in girls in the general adolescent
18
19 300 population.[24] We found higher rates in girls. This difference could indicate
20
21 301 that girls exposed to drug or alcohol misuse are more likely to be injured,
22
23 302 present to hospital, or be admitted after presenting to hospital, as a result.
24
25 303 Our estimated rates of re-admission of any type (including non-emergency
26
27 304 and non-injury) for victimisation (girls 53.3%, boys 35.1%) (Table 2) and self-
28
29 305 harm (girls 48.8%, boys 43.0%) were higher than previously reported (11% for
30
31 306 victimisation, 33% for self-harm).[3 4] These discrepancies are likely to be
32
33 307 because we considered the whole ten years of adolescence and re-admission
34
35 308 of any type, whereas previous studies looked at re-attendance up to the
36
37 309 following year and for the same type of adversity-related injury.[3 4]

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39 310 The results of this study should inform policy initiatives and national
40
41 311 guidelines. Firstly, a substantial proportion of adolescents are affected by
42
43 312 adversity and they account for a large proportion (29.6-59.9%) of all
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45 313 emergency admissions to hospital for injury in this age group. Secondly, we
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47 314 show the large burden of injury admission for all three types of adversity, yet
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49 315 there are currently no national clinical guidelines for managing assault.
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51 316 Finally, these results show that adolescents often present with multiple types
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3 317 of adversity (especially in girls), even though guidelines exist only for
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5 318 managing individual problems.[30-32]
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7 319 In addition, policy makers need to be aware of the widely varying
8
9 320 aetiological pathways to admission with adversity-related injury. Our
10
11 321 approach to defining this group of adolescents is not designed to reflect the
12
13 322 complexity or severity of these cases. For example, admission for multiple
14
15 323 types of adversity-related injury is a poor proxy indicator of severity. Effective
16
17 324 interventions will need to be tailored to the individual, based on specialist
18
19 325 clinical assessment. However, all three types of adversity are likely to reflect
20
21 326 a combination of underlying psychosocial need and environmental and social
22
23 327 stressors. This intervention may reduce the risk of future harm including the
24
25 328 incidence of other types of harm not seen in hospital, e.g., further adversity-
26
27 329 related injury not leading to admission, that are likely to be more frequent in
28
29 330 these adolescents, and which the hospital administrative data we used does
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31 331 not capture. Further work in admissions data linked to other administrative
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33 332 datasets, e.g., accident and emergency data, could tell us if the risk of these
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35 333 other types of harm is also increased in adolescents admitted with adversity-
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37 334 related injury.
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5 335 **Contributors**
6

7 336 Annie Herbert - helped to conceive and design the study, analysed and
8
9 337 interpreted the data, drafted the article, revised it critically for important
10
11 338 intellectual content and approved the final version to be published.

12
13 339 Leah Li - helped to conceive and design the study, interpreted the data,
14
15 340 revised the article critically for important intellectual content and approved the
16
17 341 final version to be published.

18
19 342 Arturo González-Izquierdo - helped to conceive and design the study,
20
21 343 acquired and interpreted the data, revised the article critically for important
22
23 344 intellectual content and approved the final version to be published.

24
25 345 Ruth Gilbert – helped to conceive and design the study, acquired and
26
27 346 interpreted the data, revised the article critically for important intellectual
28
29 347 content and approved the final version to be published.

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31 348
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33

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36 350

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48
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52
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2
3 359 writing of the manuscript or the decision to submit the paper for publication,
4
5 360 and the authors' work was independent of their funders.
6

7 361

8
9 362 **Ethics** Both Hospital Episode Statistics (HES) admissions data and Office for
10
11 363 National Statistics (ONS) mid-year population estimates are derived from
12
13 364 routinely collected administrative data. HES data were pseudonymised
14
15
16 365 before we received them and therefore we did not require Research Ethics
17
18 366 Committee approval.
19

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23 368 **Data sharing** No additional data available.
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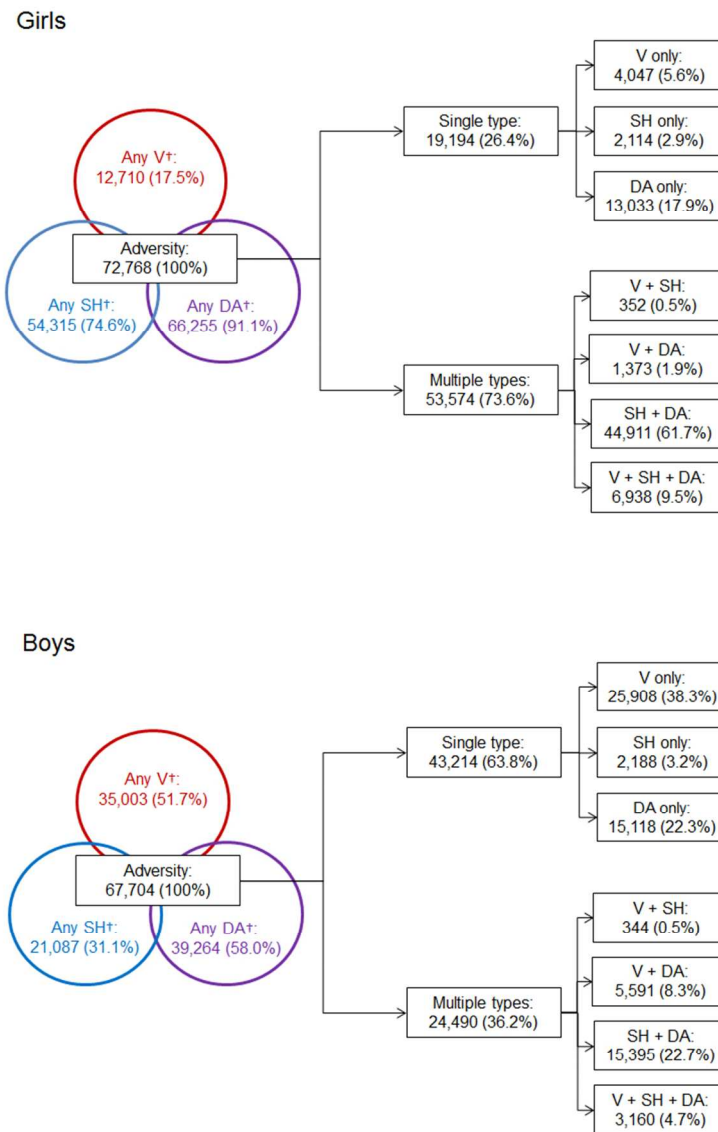


Figure 1. Number (%) of adolescents with adversity-related injury, by types of adversity between 10 and 19 years old* and sex.

V = victimisation, SH = self-harm, DA = drug or alcohol misuse

*Each adolescent classified by all adversity recorded at any emergency admission(s) for injury between 10 and 19 years old.

†'Any V', 'Any SH' and 'Any DA' are not mutually exclusive.
214x315mm (96 x 96 DPI)

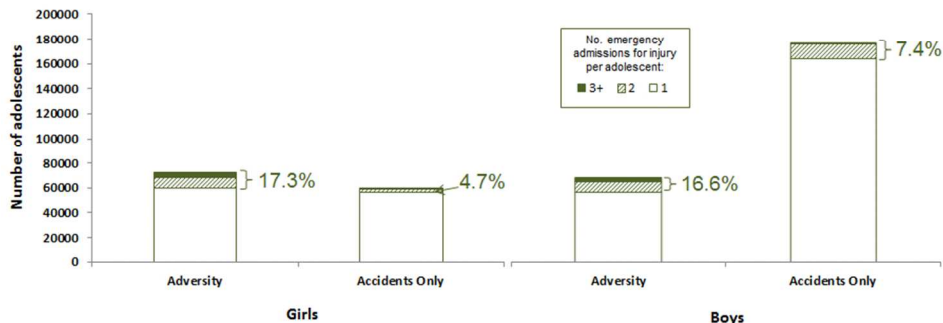


Figure 2. Number of adolescents with 1, 2 and 3 or more emergency admission(s) for injury between 10 and 19 years old*, by types of injury between 10 and 19 years old† and sex

AdvRI = Adversity-related Injury, AccRI Only = Accident-related Injury Only

*Percentages are of adolescents who have 2 or more emergency admissions for injury between 10-19 years old.

†Each adolescent classified by all adversity/accidents recorded at any emergency admission(s) for injury.
251x104mm (96 x 96 DPI)

Review only

Supplementary Tables

Supplementary Table 1. Cohort (shaded) who have at least one emergency admission for injury between 10 and 19 years old in 1998-2011 (N = 402,916)

1998	1999	2000	2001	2002	...	2007	2008	2009	2010	2011
6	7	8	9	10	...	15	16	17	18	19
7	8	9	10	11	...	16	17	18	19	20
8	9	10	11	12	...	17	18	19	20	21
9	10	11	12	13	...	18	19	20	21	22
10	11	12	13	14	...	19	20	21	22	23

Supplementary Table 2. Definitions and International Classification of Diseases (ICD-10) diagnostic codes used to classify emergency admissions for injury, chronic conditions and types of adversity*

ADMISSIONS AND ADMISSION TYPES

Admission

Admissions were defined by linked episodes of inpatient care, including day cases (any case > 4 hours stay). Any admission which occurred within one day or was a hospital transfer from a previous admission was considered to be the same admission. An episode may have up to 20 diagnosis codes entered, but 88% of admissions in this cohort had episodes with four or less diagnoses recorded (data not shown).

Emergency (acute; unplanned) admission

An admission was considered to be an emergency if the method of admission variable ('admimeth') was 21-24 or 28.(1)

Injury

An admission was considered to be for injury if any of the diagnosis codes in the first episode of the admission were S or T codes (Chapter XIX of the ICD -10).

CHRONIC CONDITIONS

ICD-10 codes as per Hardelid et al, 2013,(2) excluding E24.4, F10-F19, G31.2, G40.5, G62.1, G72.1, K29.2, K70, K85.2, K86.0, O35.4, R78.1-R78.5, Z50.2, Z50.3, Z86.4, X64-X84, Y10-Y34, Z91.5, F30.0-F30.2, F30.8-F32.3, F32.8-F334, F33.8-F34.1, F34.8-F34.9, F38.0-F38.1, F38.8, F39-F40.2, F40.8- F41.3, F41.8-F41.9.

ADVERSITY CLUSTERS AND DESCRIPTIONS*

ICD-10 CODES

Victimisation

Maltreatment

Maltreatment syndromes

T74

1		
2		
3	Effects of other deprivation (extreme neglect)	T73
4		
5	Perpetrator of neglect and other maltreatment syndromes	Y06, Y07
6		
7	<i>Assault</i>	
8		
9	Assault by bodily force and sexual assault	Y04, Y05
10		
11	Other types of assault	X85 - Y03, Y08 - Y09
12		
13		
14	<i>Undetermined cause</i>	
15		
16	Events of undetermined intent	Y20 - Y34
17		
18	Examination and observation following other inflicted injury	Z04.5
19		
20	Examination and observation for other reasons: request	
21		Z04.8
22		
23	for expert evidence	
24		
25	<i>Adverse social circumstances</i>	
26		
27	Neonatal withdrawal symptoms from maternal use of	
28		P96.1
29	drugs of addiction	
30		
31		
32	Other problems related to physical environment	Z58.8
33		
34	Problem related to physical environment, unspecified	Z58.9
35		
36	Homelessness	Z59.0
37		
38	Inadequate housing	Z59.1
39		
40	Lack of adequate food	Z59.4
41		
42		
43	Extreme poverty	Z59.5
44		
45	Insufficient social insurance and welfare support	Z59.7
46		
47	Problem related to housing and economic circumstances,	
48		Z59.9
49	unspecified	
50		
51		
52	Problems related to social environment	Z60
53		
54	Problems related to negative life events in childhood	Z61
55		
56	Other problems related to upbringing	Z62
57		
58		
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3	Other problems related to primary support group	Z63
4		
5	Discord with counsellors	Z64.4
6		
7	Problems related to other legal circumstances	Z65.3
8		
9	Other specified problems related to psychosocial	
10		
11		Z65.8
12	circumstances	
13		
14	Problem related to unspecified psychosocial	
15		Z65.9
16	circumstances	
17		
18	Problems related to lifestyle	Z72.3 - Z72.9
19		
20	Problems related to care-provider dependency	Z74
21		
22	Health supervision and care of foundling	Z76.1
23		
24	Health supervision and care of other healthy infant and	
25		
26		Z76.2
27	child	
28		
29	Family history of mental and behavioural disorders	Z81
30		
31	Personal history of other specified risk-factors, not	
32		Z91.8
33	elsewhere classified	
34		
35		
36		
37		

Self-harm

38		
39		
40	<i>Intentional self-poisoning by and exposure to...</i>	
41		
42	...drugs	X60-X63
43		
44	...other and unspecified drugs, medicaments and	
45		X64
46	biological substances	
47		
48	...alcohol	X65
49		
50	...organic solvents and halogenated hydrocarbons and	
51		X66
52	their vapours	
53		
54	...other gases and vapours	X67
55		
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2		
3	...pesticides	X68
4		
5	...other and unspecified chemicals and noxious	
6		X69
7	substances	
8		
9	<i>Intentional self-harm by...</i>	
10		
11	...hanging, strangulation and suffocation	X70
12		
13	...drowning and submersion	X71
14		
15	...firearm discharge	X72-X74
16		
17	...explosive material	X75
18		
19	...smoke, fire and flames, or steam, hot vapours and hot	
20		X76-X77
21	objects	
22		
23	...sharp/blunt objects	X78-X79
24		
25	...jumping from a high place	X80
26		
27	...jumping or lying before a moving object, or crashing a	
28		X81-82
29	motor vehicle	
30		
31	...other specified means	X83
32		
33	...unspecified means	X84
34		
35	<i>Personal history of self-harm</i>	Z91.5
36		
37		
38		
39		
40		
41		
42	Alcohol/drug misuse	
43		
44	<i>Alcohol</i>	
45		
46	Alcohol-induced pseudo-Cushing's syndrome	E24.4
47		
48	Mental and behavioural disorders due to use of alcohol	F10
49		
50	Degeneration of nervous system due to alcohol	G31.2
51		
52	Alcoholic polyneuropathy	G62.1
53		
54	Alcoholic myopathy	G72.1
55		
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3	Alcoholic cardiomyopathy	I42.1
4		
5	Alcoholic gastritis	K29.2
6		
7	Alcoholic liver disease	K70
8		
9		
10	Alcohol-induced acute pancreatitis	K85.2
11		
12	Alcohol-induced chronic pancreatitis	K86.0
13		
14	Maternal care for (suspected) damage to fetus from	
15		O35.4
16	alcohol	
17		
18	Fetus and newborn affected by maternal use of alcohol [†]	P04.3
19		
20	Fetal alcohol syndrome (dysmorphic) [†]	Q86.0
21		
22		
23	Finding of alcohol in blood	R78.0
24		
25	Poisoning: antidotes and chelating agents, not elsewhere	
26		T50.6
27	classified	
28		
29	Toxic effect of alcohol	T51
30		
31	Accidental poisoning by exposure to alcohol	X45
32		
33		
34	Intentional self poisoning by and exposure to alcohol**	X65
35		
36	Poisoning by exposure to alcohol, undetermined intent	Y15
37		
38	Evidence of alcohol involvement determined by blood	
39		Y90
40		
41	alcohol level	
42		
43	Evidence of alcohol involvement determined by level of	
44		Y91
45	intoxication [‡]	
46		
47	Alcohol rehabilitation	Z50.2
48		
49	Alcohol abuse counselling and surveillance	Z71.4
50		
51	Alcohol use [‡]	Z72.1
52		
53		
54	<i>Drugs, medicaments and biological substances (illicit drugs)</i>	
55		
56	Mental and behavioural disorders due to psychoactive	F11 - F17, F19
57		
58		
59		
60		

1
2
3 substance use

4
5 Maternal care for (suspected) damage to fetus by drugs[†] O35.5

6
7 Neonatal jaundice due to drugs or toxins transmitted from
8
9 mother or given to newborn[†] P58.4

10
11 Neonatal withdrawal symptoms from maternal use of
12
13 drugs of addiction[†] P96.1

14
15 Finding of drugs not normally found in blood R78.1 - R78.5

16
17 Poisoning by drugs, medicaments and biological T36 - T50

18
19 substances (not inc. T50.6)

20
21 Intentional self poisoning by and exposure to antiepileptic,
22
23 sedative-hypnotic, antiparkinsonism and psychotropic drugs,
24
25 not elsewhere classified** X61

26
27 Intentional self poisoning by and exposure to other drugs
28
29 acting on the autonomic nervous system** X63

30
31 Intentional self poisoning by and exposure to other and
32
33 unspecified drugs, medicaments and biological substances** X64

34
35 Assault by drugs, medicaments and biological substances[§] X85

36
37 Poisoning, undetermined intent Y10 - Y14

38
39 Drug rehabilitation Z50.3

40
41 Drug abuse counselling and surveillance Z71.5

42
43 Drug use Z72.2

44
45 *Environmental/ Domestic substances*

46
47 Mental and behavioural disorders due to use of volatile
48
49 solvents F18

50
51 Accidental poisoning by and exposure to noxious X40 – X44, X46 - X49

1		
2		
3	substances	
4		
5	Intentional self-poisoning by and exposure to organic	
6		X66
7	solvents and halogenated hydrocarbons and their vapours[†]	
8		
9	Intentional self-poisoning by and exposure to noxious	
10		X69
11	substances	
12		
13		
14	Assault by unspecified chemical or noxious substance[§]	X90
15		
16	Poisoning by chemical or noxious substance,	
17		Y16 - Y19
18	undetermined intent	
19		
20		
21	<i>Codes mentioning both alcohol and drugs</i>	
22		
23	Special epileptic syndromes - (related to alcohol, drugs,	
24		G40.5
25	etc.)	
26		
27	Blood-alcohol and blood-drug test	Z04.0
28		
29		
30	Personal history of psychoactive substance abuse—	
31		Z86.4
32	(alcohol, drug, tobacco) ^{***}	
33		
34		
35		
36	Accidents	
37		
38	Transport accidents	V01 - V99
39		
40	Falls	W00 - W19
41		
42	Exposure to inanimate mechanical forces	W20 - W49
43		
44	Exposure to animate mechanical forces	W50 - W64
45		
46	Accidental drowning and submersion	W65 - W74
47		
48	Other accidental threats to breathing	W75 - W84
49		
50	Exposure to electric current, radiation and extreme	
51		W85 - W99
52	ambient air temperature and pressure	
53		
54	Exposure to smoke, fire and flames	X00 - X09
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3	Contact with heat and hot substances	X10 - X19
4		
5	Contact with venomous animals and plants	X20 - X29
6		
7	Exposure to forces of nature	X30 - X39
8		
9	Accidental poisoning by and exposure to noxious	
10		
11		X40 - X49
12	substances	
13		
14	Overexertion, travel and privation	X50 - X57
15		
16	Accidental exposure to other and unspecified factors	X58 - X59
17		

* 'Strikethrough' (~~Phrase, code~~) indicates that this was not included in the adversity definition.

† Codes relating to foetuses or neonates (P04.3, Q86.0, P58.4 and P96) were not expected in adolescent presentations; this was checked and did not appear.

** Formed part of the self-harm cluster only; self-poisoning considered most egregious element of diagnosis.

‡ If subject under 18 years old.

§ Formed part of the victimisation cluster only; assault considered most egregious element of the diagnosis.

***Not possible to distinguish whether for drugs, alcohol or tobacco

Supplementary Table 3. Population prevalence* of emergency admission(s) for injury, by types of adversity within age periods† and sex

Adolescent group†	All girls	All boys	Girls			Boys		
	10-19y	10-19y	10-14y	15-17y	18-19y	10-14y	15-17y	18-19y
All	8.66	16.27‡	3.92	3.12§	2.11§	7.67‡	5.29‡§	0.40‡§
AdvRI	4.37	4.26‡	1.31	2.04§	1.27§	0.72‡	1.53‡§	1.74‡§
Any Victimization	0.76	2.20‡	0.25	0.31§	0.19§	0.33‡	0.80‡§	0.90‡§
Any Self-harm	3.26	1.33‡	0.90	1.58§	0.97§	0.22‡	0.47‡§	0.55‡§
Any Drug or Alcohol Misuse	3.98	2.47‡	1.16	1.87§	1.15§	0.39‡	0.84‡§	1.01‡§
Single adversity	1.15	2.72‡	0.44	0.49§	0.32§	0.53‡	0.99‡§	1.08‡§
Victimization Only	0.24	1.63‡	0.09	0.10§	0.08§	0.28‡	0.64‡§	0.69‡§
Self-harm Only	0.13	0.14	0.05	0.06§	0.03§	0.05	0.04‡§	0.04‡
Drug or Alcohol Misuse Only	0.78	0.95‡	0.29	0.33§	0.21§	0.21‡	0.31‡§	0.35‡§

Adolescent group†	All girls	All boys	Girls			Boys		
	10-19y	10-19y	10-14y	15-17y	18-19y	10-14y	15-17y	18-19y
Multiple adversity	3.22	1.54‡	0.88	1.55§	0.95§	0.19‡	0.54‡§	0.66‡§
V+SH	0.02	0.02	0.01	0.01	0.004§	0.005‡	0.01§	0.01‡
V+DA	0.08	0.35‡	0.03	0.03	0.02§	0.02‡	0.11‡§	0.15‡§
SH+DA	2.70	0.97‡	0.72	1.34§	0.84§	0.14‡	0.37‡§	0.45‡§
V+SH+DA	0.42	0.20‡	0.12	0.17§	0.09§	0.02‡	0.05‡§	0.06‡§
No adversity	4.29	12.01‡	2.79	1.08§	0.84§	6.95‡	3.76‡§	2.26‡§
AccRI Only	0.71	1.00‡	0.32	0.26§	0.24§	0.47‡	0.36‡§	0.31‡§
Other Causes	3.58	11.01‡	2.47	0.82§	0.60§	6.48‡	3.40‡§	1.95‡§

V = Victimisation, SH = Self-harm, DA = Drug or Alcohol Misuse, AdvRI = Adversity-related Injury, AccRI Only = Accident-related Injury Only

*Due to large denominators, confidence intervals for population prevalence were too narrow to provide any meaningful interpretation and so are not shown.

†Each adolescent classified by all adversity/accidents seen at any emergency injury admission(s) at 10-19 years, 10-14 years, 15-17 years and 18-19 years, respectively.

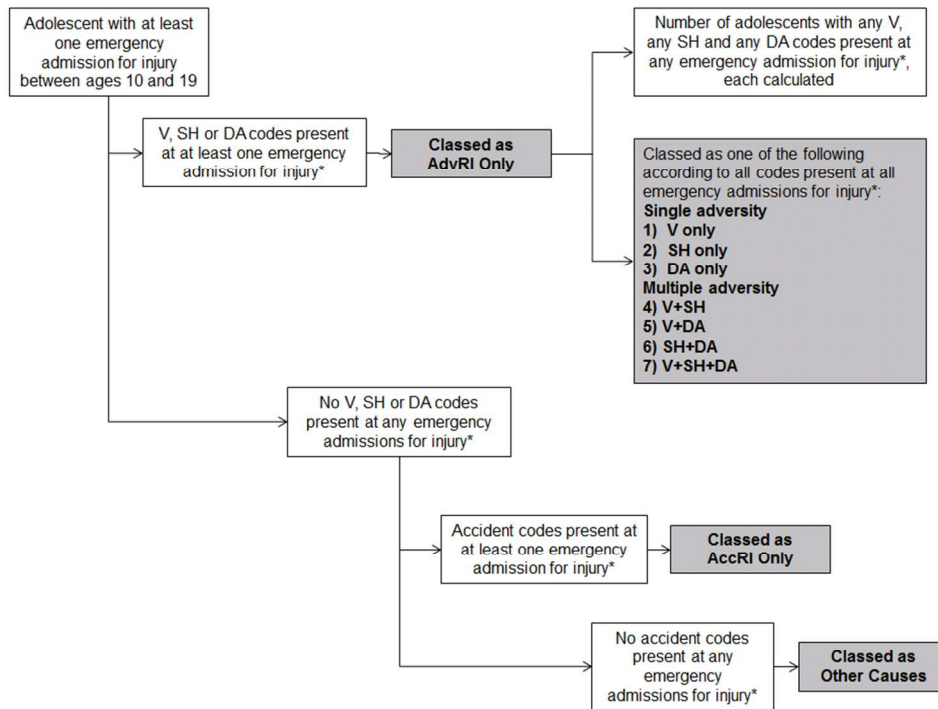
‡Statistically significantly different from girls of the same age (according to 95% confidence intervals).

§Statistically significantly different from 10-14 year olds of the same sex (according to 95% confidence intervals).

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1. Inpatient HES Data Dictionary. Leeds: Health and Social Care Information Centre, 2010.
2. Hardelid P DN, Davey J, Primbramska I, Gilbert R. Overview of child deaths in the four UK countries. London: 2013.

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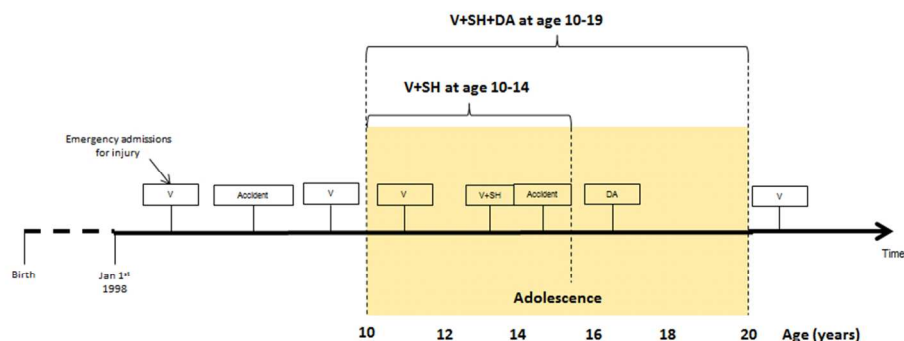
Supplementary Figure 1. Classification of groups of adolescents.

V = victimisation, SH = self-harm, DA = Drug or alcohol misuse, AdvRI = Adversity-related injury, AccRI Only = Accident-related injury only.

*between ages 10 and 19.

262x201mm (96 x 96 DPI)

only



Supplementary Figure 2. Example of classification of groups of adolescents within age groups and across adolescence (ages 10-19).

V = victimisation, SH = self-harm, DA = drug or alcohol misuse.
 254x102mm (96 x 96 DPI)

er review only

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract (b) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported
Objectives	3	State specific objectives, including any prespecified hypotheses
Methods		
Study design	4	Present key elements of study design early in the paper
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants	6	(a) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up <i>Case-control study</i> —Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants (b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed. N/A <i>Case-control study</i> —For matched studies, give matching criteria and the number of controls per case
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
Bias	9	Describe any efforts to address potential sources of bias. We only analysed those who could be observed between ages 10 and 19, so no bias due to different lengths of admission trajectories.
Study size	10	Explain how the study size was arrived at. All available administrative data.
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding (b) Describe any methods used to examine subgroups and interactions (c) Explain how missing data were addressed. N/A (d) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed. We only analysed those who could be observed between ages 10 and 19. <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed <i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy (e) Describe any sensitivity analyses. N/A

Continued on next page

Results

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed (b) Give reasons for non-participation at each stage. <i>N/A</i> (c) Consider use of a flow diagram. <i>We didn't use a flow diagram as eligibility could be described using one sentence.</i>
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (b) Indicate number of participants with missing data for each variable of interest (c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount). <i>N/A</i>
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time. <i>We state how many emergency admissions for adversity-related injury the AdvRI group had. We also provide a table indicating the number of emergency admissions for injury and admissions (of any type) during ages 10-19.</i> <i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure <i>Cross-sectional study</i> —Report numbers of outcome events or summary measures
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included. <i>We gave prevalence estimates stratified by age-group and sex.</i> (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period. <i>N/A</i>
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions; and sensitivity analyses

Discussion

Key results	18	Summarise key results with reference to study objectives
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability	21	Discuss the generalisability (external validity) of the study results

Other information

Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based
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*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Violence, self-harm and drug or alcohol misuse in adolescents admitted to hospitals in England for injury: a retrospective cohort study

Journal:	<i>BMJ Open</i>
Manuscript ID:	bmjopen-2014-006079.R1
Article Type:	Research
Date Submitted by the Author:	29-Dec-2014
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Primary Subject Heading:	Paediatrics
Secondary Subject Heading:	Mental health, Health services research
Keywords:	MENTAL HEALTH, Non-accidental injury < PAEDIATRICS, Substance misuse < PSYCHIATRY, Suicide & self-harm < PSYCHIATRY

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5 **1 Violence, self-harm and drug or alcohol misuse in**
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7 **2 adolescents admitted to hospitals in England for injury: a**
8
9 **3 retrospective cohort study**
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35

36
37 Short title: Adversity in adolescents admitted to hospital for injury
38

39 *Key words: Wounds and Injuries, Violence, Self-injurious Behaviour,*
40 *Substance-related Disorders, Adolescent*
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7 **ABSTRACT**

8 **Objectives**

9
10 Of adolescents in the general population in England, we aimed to determine
11
12 1) the proportion that has an emergency admission to hospital for injury
13
14 related to adversity (violence, self-harm or drug or alcohol misuse) and 2) the
15
16 risk of recurrent emergency admissions for injury in adolescents admitted with
17
18 adversity-related injury compared with those admitted with accident-related
19
20 injury only.
21
22

23 **Design**

24 We used longitudinally-linked administrative hospital data (Hospital Episode
25
26 Statistics) to identify 10-19 year olds with emergency admissions for injury
27
28 (including day cases lasting more than four hours), in England in 1998-2011.
29
30 We used Office for National Statistics mid-year estimates for population
31
32 denominators.
33
34

35 **Results**

36
37 Approximately 4.3% (n=141 248) of adolescents in the general population
38
39 (n=3 254 046) had one or more emergency admissions for adversity-related
40
41 injury (girls 4.6%, boys 4.1%), accounting for 50.0% of all emergency
42
43 admissions for injury in girls and 29.1% in boys. Admissions for self-harm or
44
45 drug or alcohol misuse commonly occurred in the same girls and boys.
46
47 Recurrent emergency admissions for injury were more common in
48
49 adolescents with adversity-related injury (girls 17.3%; boys 16.5%) than in
50
51 those with accident-related injury only (girls 4.7%; boys 7.4%), particularly for
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3 48 adolescents with adversity-related injury related to multiple types of adversity
4
5 49 (girls 21.1%; boys 24.2%).
6

7 50 **Conclusion**
8

9
10 51 Hospital-based interventions should be developed to reduce the risk of future
11
12 52 injury in adolescents admitted for adversity-related injury.
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3 53 **What is already known on this subject**
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- 5 54 • Adolescents exposed to adversity (violence, self-harm or drug or
6 alcohol misuse) often use health services, and repetitively.
7 55
8
9 56 • Many adolescents in the general population are exposed to multiple
10 types of adversity during their adolescence.
11 57
12
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16

17 59 **What this study adds**

- 18
19 60 • One in 20 adolescents in England has an emergency admission to
20 hospital for adversity-related injury between 10 and 19 years old.
21 61
22
23 62 • Many adolescents admitted with adversity-related injury (particularly
24 girls) are admitted with multiple types of adversity, self-harm and drug
25 or alcohol misuse being the most common combination.
26 63
27
28 64
29
30 65 • Re-admission is more common in these adolescents than those
31 admitted with accident-related injury only.
32 66
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35
36

37 68 **Strengths and limitations of this study**

- 38
39 69 • Hospital Episodes Statistics (HES) captured data on all admissions to
40 National Health Service hospitals in England at 10-19 years old in this
41 study's cohort.
42 70
43
44 71
45
46 72 • The longitudinal link between admissions for each individual in HES
47 data allowed us to study the burden of multiple emergency admissions
48 for injury over time.
49 73
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51 74
52
53 75 • However, violence, self-harm and drug or alcohol misuse are not
54 always recognised at an admission, or consistently recorded, and
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77 therefore this study's estimates of prevalence of adversity are likely to
78 be underestimates.

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1
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3 79 **INTRODUCTION**
4

5 80 Many adolescents exposed to adversity such as violence, self-harm, or drug
6
7 81 or alcohol misuse use secondary health services,[1 2] often repetitively.[3 4]
8
9 82 For example, in a self-report survey of 15-16 year olds in England, 12.6% of
10
11 83 those who had self-harmed had presented to hospital.[2] It is also estimated
12
13 84 that approximately one-third of patients attending a hospital in England for
14
15 85 self-harm re-attend for self-harm in the following year.[4] Improved
16
17 86 management of adolescents exposed to adversity could reduce risk of
18
19 87 repetition as well as the burden on secondary care.[5-7]
20
21

22
23 88 An admission to hospital provides the 'teachable moment'. [8] That is,
24
25 89 both adolescents and their families may be more likely to engage with an
26
27 90 intervention than if they had received it elsewhere. Hospital-based
28
29 91 interventions to reduce the risk of future harm could benefit these adolescents
30
31 92 by reducing episodes of injury, and may reduce recurrent emergency (i.e.,
32
33 93 acute or unplanned) admissions for injury.
34
35

36 94 To date, there is a lack of evidence on how different types of adversity-
37
38 95 related injury occur in the same adolescents over time. In addition, policy
39
40 96 makers and service providers need to know how many adolescents have an
41
42 97 emergency admission to hospital for adversity-related injury, their
43
44 98 characteristics and their specific rates of re-admission if they are to be
45
46 99 feasibly targeted for intervention.
47
48

49
50 100 In this study we used administrative hospital data and Office for
51
52 101 National Statistics (ONS) mid-year population estimates to estimate the
53
54 102 number of adolescents in the general population who have ever had an
55
56 103 emergency admission to hospital for injury. We then estimated the
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3 104 prevalence of emergency admissions for injury related to violence, self-harm
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5 105 and drug or alcohol misuse (alone and co-occurring) in the general
6
7 106 population. Finally, we determined the risk of recurrent emergency
8
9
10 107 admissions for injury in adolescents who had at least one admission between
11
12 108 10 and 19 years for adversity-related injury compared with adolescents only
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14 109 ever admitted for accidental injury during the same period.
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110 **METHODS**

111 **Study population**

112 Using administrative data from all admissions to National Health Service
113 hospitals in England (Hospital Episode Statistics [HES]) in 1998-2011,[9] we
114 derived a retrospective cohort of adolescents who turned 10 years old in
115 1998-2002, who could be observed throughout adolescence until 19 years old
116 (Supplementary Table 1).[10] Each individual also had to have at least one
117 emergency admission for injury between 10 and 19 years old.

118 **Admission data**

119 The Health and Social Care Information Centre provided pseudonymised data
120 on hospital admissions, use of which did not require Research Ethics
121 Committee approval.[11] An admission is defined by the National Health
122 Service as any hospital case lasting longer than four hours, and so includes
123 long day cases as well as overnight stays. We analysed any hospital
124 transfers or admissions within one day after discharge as the same
125 admission, as previously described.[12] We used the variable for method of
126 admission ('admimeth') to define an emergency admission. We used all
127 International Classification of Diseases-10 (ICD-10) diagnosis codes recorded
128 during an admission to categorise admissions as being for injury related to
129 adversity or an accident (Supplementary Table 2).[13]

130 **Types of injury and age at emergency admission**

131 We defined an emergency admission for injury as being related to adversity,
132 comprising violence (maltreatment/assault/undetermined causes of injury),

1
2
3 133 self-harm or drug or alcohol misuse, using mutually exclusive clusters of ICD-
4
5 134 10 codes (Supplementary Table 2). Violence was defined by previously-
6
7 135 validated codes, which would trigger consideration of violence by carers,
8
9
10 136 peers or strangers.[12 14 15] We defined self-harm using codes that
11
12 137 mentioned either 'self-harm' or 'self-poisoning'. Drug or alcohol misuse was
13
14 138 defined by codes that mentioned 'alcohol', 'drugs', 'noxious substance' or
15
16 139 'solvent'. We defined an injury as being related to accidents only if no
17
18 140 adversity codes were present but there were codes from the ICD-10
19
20
21 141 *Accidents* subchapter (V01-X59).[13]

22
23 142 We grouped age at each admission to reflect age of onset of puberty
24
25 143 (10-14 years), age of sitting secondary school exams (15-17 years) and the
26
27 144 legal age for buying alcohol (18-19 years).[16-19]

28
29
30 145 **Classification of adolescents according to types of injury and age at**
31
32 146 **emergency admissions**

33
34
35 147 We classed adolescents into groups according to all of their emergency
36
37 148 admissions for injury between 10 and 19 years old. Adolescents were
38
39 149 classed as belonging to the 'adversity' group (any adversity-related injury
40
41 150 between 10 and 19 years old), 'accidents only' group (no adversity-related
42
43 151 injury but one or more accident-related injuries) or 'other causes' group (no
44
45 152 adversity-related or accident-related injuries) (Supplementary Figure 1).
46
47
48 153 Among adolescents in the adversity group, we determined the proportion
49
50 154 exposed to violence-, self-harm- and drug or alcohol misuse-related injury at
51
52 155 age 10-19, respectively. We further classified the adversity group into seven
53
54 156 mutually exclusive sub-groups: violence only, self-harm only, drug or alcohol
55
56 157 misuse only, violence and self-harm, violence and drug or alcohol misuse,
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3 158 self-harm and drug or alcohol misuse, and violence, self-harm and drug or
4
5 159 alcohol misuse.
6

7 160 We also grouped adolescents as above, according to their emergency
8
9 161 admissions for injury at 10-14 years only, 15-17 years only and 18-19 years
10
11 162 only (Supplementary Figure 2).
12

13 163 **Population denominators**

14 164 We used ONS mid-year population estimates to derive population
15
16 165 denominators.[20 21] These data are freely available online broken down by
17
18 166 sex and year of age.
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24 167 **Analyses**

25 168 We estimated the proportion of adolescents in the general population who had
26
27 169 an emergency admission for injury between 10 and 19 years old. We used
28
29 170 the number of adolescents in our derived retrospective cohort as the
30
31 171 numerator and ONS mid-year estimates for 10 year olds in 1998-2002 as the
32
33 172 population denominator. We then calculated these proportions by types of
34
35 173 injury at 10-19 years old (adversity-related [adversity group and seven
36
37 174 mutually exclusive subgroups] and accidents only [accidents only group]) and
38
39 175 by age group, as described above.
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44 176 We calculated the proportion of adolescents in the adversity group (and
45
46 177 subgroups) and in the accidents only group who had an emergency admission
47
48 178 for injury twice and three or more times between 10 and 19 years old. We
49
50 179 also calculated the proportions of adolescents with two or three or more
51
52 180 admissions of any type (including non-emergency and non-injury).
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55 181 We reported all results separately for girls and boys since differences
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57 182 between girls and boys have been reported for prevalence of adversity in the
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183 general population.[1 22-24] We calculated 95% confidence intervals for all
184 proportions but did not present them here as they were all too narrow to
185 convey any useful information (within one unit of the sample estimate).
186 Analyses were carried out in StataSE 12.

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5 187 **RESULTS**
6

7 188 There were 1 033 702 adolescents in HES admissions data in 1998-2011, of
8
9 189 which 402 916 formed the study cohort (462 476 emergency admission for
10
11 190 injury when considering multiple presentations from the same adolescent, 802
12
13 191 682 admissions of any type [including non-emergency and non-injury, 662
14
15 192 727 of which were overnight stays]) (Table 1), representing 12.4% (402 916/3
16
17 193 254 046) of the adolescent population. Twice as many boys as girls had an
18
19 194 emergency admission for injury during adolescence (144 158/1 588 942 girls
20
21 195 in the population [8.7%]; 258 503/1 665 104 boys [16.3%]).
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196 **Table 1.** Characteristics of adolescents whose entire ten years of adolescence (ages 10-19) occurred in 1998-2011.

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Characteristics	Adolescent population*	Adolescents with emergency admission(s) for injury between 10 and 19 years old, n (row %)			
	Total	Total	Adversity	Accidents only	Other causes
All	3,254,046	402,916 (100.0)	141,248 (35.1)	233,907 (58.1)	27,761 (6.9)
Age**					
Girls	1,588,942	144,158 (100.0)	72,805 (50.5)	59,528 (41.3)	11,888 (8.2)
10-14 years	.	65,208 (100.0)	23,178 (35.5)	37,388 (57.3)	4,642 (7.1)
15-17 years	.	48,286 (100.0)	31,573 (65.4)	12,922 (26.8)	3,791 (7.9)
18-19 years	.	30,664 (100.0)	18,054 (58.9)	9,155 (29.9)	3,455 (11.3)
Boys	1,665,104	258,503 (100.0)	68,403 (26.5)	174,267 (67.4)	15,833 (6.1)
10-14 years	.	121,821 (100.0)	17,667 (14.5)	97,478 (80.0)	6,676 (5.5)
15-17 years	.	79,223 (100.0)	25,014 (31.6)	49,345 (62.3)	4,864 (6.1)
18-19 years	.	57,459 (100.0)	25,722 (44.8)	27,444 (47.8)	4,293 (7.5)
Missing (Sex)	.	255 (100.0)	40 (15.7)	175 (68.6)	40 (15.7)

198 *Based on ONS mid-year England statistics for 10 year olds in 1998-2002.[20]

199 **At first emergency admission for injury

200 **Types of injury and age at emergency admission**

201 One-third of the cohort (141 248, 4.3% of the population) had a record of an
202 emergency admission for adversity-related injury between 10 and 19 years
203 old (the adversity group; 157 004 emergency admissions for adversity-related
204 injury in total) (Table 1), with similar rates between sexes (72 805, 4.6% girls
205 in the population; 68 403, 4.1% boys).

206 The remaining two-thirds of the cohort (261 668, 8.1% of the
207 adolescent population) had emergency admissions for injury which were
208 never related to adversity (Table 1). Among these adolescents, 233 907
209 (89.4%) had an accident-related injury (the accidents only group, 7.2% of the
210 population) and 27 761 (10.6%) had no accident-related injury (other causes
211 group, 0.9% of the population). A high proportion of the other causes group
212 were affected by a chronic condition¹ between 10 and 19 years old (11 221/27
213 761, 40.4%), compared with the adversity group (45 321/141 248, 32.1%) or
214 accidents only group (49 434/233 907, 21.1%).

215 Proportions of adolescents in the general population and within
216 individual age groups by adversity [and subgroups], accidents only, and other
217 causes groups are provided in Supplementary Table 3.

218 **Types of adversity-related injury**

219 Among adolescents in the adversity group (girls 72 805, boys 68 403) (Figure
220 1), the most common type of adversity was drug or alcohol misuse (girls
221 91.5%, boys 60.0%). A higher proportion of boys than girls were exposed to

¹ Defined by ICD-10 codes (Supplementary Table 2)

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3 222 violence (girls 8.5%, boys 47.6%), but a higher proportion of girls than boys
4
5 223 were exposed to self-harm (girls 74.6%; boys 32.9%).
6

7 224 Girls in the adversity group were most likely to be exposed to multiple
8
9 225 types of adversity between 10 and 19 years old (69.2% + 2.0% + 1.2% + 0.2%
10
11 226 = 72.6%) (Figure 1), especially self-harm and drug or alcohol misuse (69.2%
12
13
14 227 of the entire adversity group, i.e., most of the 72.6%). Fewer boys in the
15
16 228 adversity group were exposed to multiple types of adversity (38.4%), the most
17
18 229 common combination also being self-harm and drug or alcohol misuse
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20
21 230 (24.8%).
22

23 231 For most of the adolescents who were exposed to multiple types of
24
25 232 adversity, the combination of types was recorded at the same admission. For
26
27 233 example, among the 130 adolescent girls who were exposed to violence and
28
29 234 self-harm between 10 and 19 years old (Table 2), 64.6% had both violence
30
31 235 and self-harm codes present simultaneously in at least one emergency
32
33 236 admission for injury (violence and drug or alcohol misuse 78.8%, self-harm
34
35 237 and drug or alcohol misuse 99.7%, violence, self-harm and drug or alcohol
36
37 238 misuse 33.9%; boys: violence and self-harm 40.1%, violence and drug or
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39 239 alcohol misuse 84.1%, self-harm and drug or alcohol misuse 99.1%, violence,
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41 240 self-harm and drug or alcohol misuse 20.0%) (data not shown).
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241 **Table 2.** Proportion of adolescents with 1, 2 or 3+ emergency admission(s) for injury or 1, 2 or 3+ admission(s) of any type, by
 242 types of adversity between 10 and 19 years old*

Adolescent group*	No. girls	Girls (%)						No. boys	Boys (%)					
		Emergency admission(s) for injury			Admission(s) of any type				Emergency admission(s) for injury			Admission(s) of any type		
		1	2	3+	1	2	3+		1	2	3+	1	2	3+
All	144,158	88.6	8.3	3.1	57.6	20.5	22.0	258,503	90.3	8.0	1.8	68.5	18.7	12.9
Adversity	72,805	82.7	12.0	5.3	53.8	21.1	25.1	68,403	83.5	12.4	4.1	64.8	19.4	15.8
Any violence	6,211	77.2	13.9	8.9	49.1	20.7	30.1	32,799	83.2	12.8	4.0	65.6	19.6	14.8
Any self-harm	54,315	79.3	13.9	6.8	51.2	21.5	27.3	21,087	76.7	15.8	7.5	57.0	20.7	22.3
Any drug or alcohol misuse	66,645	81.9	12.5	5.6	53.6	21.1	25.3	41,014	81.1	13.6	5.3	62.9	19.5	17.6
Single adversity	19,924	92.8	6.2	1.0	61.2	19.8	19.0	43,563	71.3	8.3	1.8	55.8	15.2	10.3
Violence only	3,734	92.4	6.3	1.3	58.1	20.4	21.6	24,912	87.1	10.6	2.2	68.3	19.2	12.6
Self-harm only	2,296	90.3	8.1	1.6	54.4	20.7	24.9	2,260	87.3	10.4	2.3	62.3	19.8	17.9
Drug or alcohol misuse only	13,894	93.3	5.9	0.8	63.2	19.5	17.4	16,391	88.5	9.5	2.1	69.9	17.9	12.2
Multiple adversity	52,881	78.9	14.2	6.9	51.0	21.6	27.4	24,840	77.3	16.7	7.5	59.0	21.0	21.5
V + SH	130	70.0	20.8	9.2	42.3	26.2	31.5	217	41.6	15.4	6.1	32.8	16.0	14.2

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V + DA	862	81.9	15.1	3.0	52.2	22.9	24.9	6,013	84.6	17.5	5.4	68.4	21.8	17.3
SH + DA	50,404	80.1	13.7	6.3	51.8	21.6	26.6	16,953	86.7	16.4	6.9	64.6	22.7	22.9
V + SH + DA	1,485	36.8	31.6	31.5	25.5	19.9	54.5	1,657	22.0	16.4	14.1	17.9	11.7	22.8
No adversity	71,353	94.7	4.5	0.8	61.4	19.9	18.7	190,100	92.4	6.3	0.9	69.5	18.3	11.8
Accidents only	59,465	95.3	4.1	0.6	66.5	18.7	14.7	174,267	92.3	6.5	0.9	71.1	18.0	10.5
Other causes	11,888	91.5	6.3	2.1	35.5	25.8	38.8	15,833	93.4	5.0	1.6	51.5	22.1	26.3

243 V = Violence, SH = Self-harm, DA = Drug or Alcohol Misuse
 244 * Each adolescent classified by all adversity/accidents seen at any emergency admission(s) for injury between 10 and 19 years old.

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4 245 **Emergency re-admissions for injury**
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6 246 Adolescent girls in the adversity group (50.5% of all girls in the cohort)
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8 247 accounted for 50.0% of the total number of emergency admissions for injury
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10 248 coming from girls (data not shown), compared with girls in the accidents only
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12 249 group (41.3% of all girls) who accounted for 36.6%. Boys in the adversity
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14 250 group (26.2% of all boys in the cohort) accounted for 29.1% compared with
15
16 251 65.0% contributed by boys in the accidents only group (67.7% of all boys).
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19 252 More adolescents in the adversity group were re-admitted for injury
20
21 253 (i.e., had two or more emergency admissions for injury) between 10 and 19
22
23 254 years old (girls 17.3%, boys 16.5%) (Figure 2), than in the accidents only
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25 255 group (girls 4.7%; boys 7.4%). Among adolescents admitted for injuries
26
27 256 related to multiple types of adversity (Table 2), the proportion re-admitted was
28
29 257 even higher (multiple types: girls 21.1%, boys 24.2%; single type: girls 7.2%,
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31 258 boys 10.1%).
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35 259 Similarly, a higher proportion of adolescents in the adversity group had
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37 260 two more admissions of any type (including non-emergency and non-injury)
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39 261 between 10 and 19 years old (girls 46.2%; boys 35.2%) (Table 2) compared
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41 262 with adolescents in the accidents only group (girls 33.4%; boys 28.5%). This
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43 263 proportion was even higher for adolescents in the adversity group who were
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45 264 admitted with multiple types of adversity (multiple types: girls 49.0%, boys
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47 265 42.5%; single type: girls 38.8%, boys 25.5%).
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3 266 **DISCUSSION**
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5 267 More than one in 20 adolescents in England had at least one emergency
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7 268 admission for adversity-related injury between 10 and 19 years old. These
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9 269 adolescents accounted for a third of all adolescents with emergency
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11 270 admissions for injury and for a disproportionate number of re-admissions for
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13 271 injury, particularly adolescents admitted with multiple types of adversity-
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15 272 related injury. Targeting adolescents admitted with adversity-related injury
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17 273 could reduce their risk of future harm, the rate of re-admissions to hospital,
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19 274 and health care costs .[25]
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23 275 Longitudinally-linked admissions allowed us to study the entire ten
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25 276 years of adolescence in 402 916 individuals. We were able, to distinguish
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27 277 between types of adversity that co-occurred during adolescence or at the
28
29 278 same admission, and to study re-admissions. One weakness of this study was
30
31 279 our reliance on diagnostic codes recorded in administrative data. Violence by
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33 280 carers, which could be coded under maltreatment, and drug or alcohol misuse
34
35 281 have been shown to be under-recorded using ICD-10,[26 27] but false
36
37 282 positives are rare.[15] To address under-recording, we used what we
38
39 283 considered to be sensitive clusters of codes for adversity. Other factors
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41 284 related to recording or coding practices,[12 14 15 27 28] for example, new
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43 285 guidelines for defining maltreatment,[14] can also affect ascertainment.
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47 286 Because of the relative insensitivity but good specificity of the coding clusters,
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49 287 some adolescents who were classified in the accidents only group may in fact
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51 288 belong to the adversity group, but did not have their adversity recognised or
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53 289 recorded. Consequently, our prevalence estimates of admission for different
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3 290 types of adversity-related injury are likely to provide a lower bound for the true
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5 291 prevalence.
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7 292 Our prevalence estimates of admission for injury related to individual
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9 293 types of adversity from the general adolescent population are consistent with
10
11 294 previous reports for emergency admissions for assault-related injury in 2004-
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13 295 2009 and for all admissions (emergency and non-emergency) for self-harm
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15 296 and drug or alcohol misuse.[1 2 24 29] Previous studies have reported higher
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17 297 rates of drug or alcohol misuse in boys than in girls in the general adolescent
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19 298 population.[24] We found higher rates in girls. This difference could indicate
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21 299 that girls exposed to drug or alcohol misuse are more likely to be injured, to
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23 300 present to hospital, or to be admitted after a hospital presentation, than boys.
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27 301 Our estimated rates of re-admission of any type (including non-
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29 302 emergency and non-injury) for violence (girls 50.8%, boys 34.4%) (Table 2)
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31 303 and self-harm (girls 48.8%, boys 43.0%) were higher than previously reported
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33 304 (11% for violence, 33% for self-harm).[3 4] These discrepancies are likely to
34
35 305 be because we considered the whole ten years of adolescence and re-
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37 306 admission of any type, whereas previous studies looked at re-attendance up
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39 307 to the following year and for the same type of adversity-related injury.[3 4]
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43 308 The results of this study should inform policy initiatives and national
44
45 309 guidelines. Firstly, a substantial proportion of adolescents are affected by
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47 310 adversity and they account for a large proportion (29.1 to 50.0%) of all
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49 311 emergency admissions to hospital for injury in this age group. Secondly, we
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51 312 show the large burden of injury admission for all three types of adversity, yet
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53 313 there are currently no national clinical guidelines for managing cases of
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55 314 violence, other than responding to violence by caregivers.[30] Finally, these
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3 315 results show that adolescents often present with multiple types of adversity
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5 316 (especially in girls), even though guidelines exist only for managing individual
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7 317 problems.[31-33]
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10 318 In addition, policy makers need to be aware of the widely varying
11
12 319 aetiological pathways to admission with adversity-related injury. Our
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14 320 approach to defining this group of adolescents is not designed to reflect the
15
16 321 complexity or severity of these cases. For example, admission for multiple
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18 322 types of adversity-related injury is a poor proxy indicator of severity. Effective
19
20 323 interventions will need to be tailored to the individual based on specialist
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22 324 clinical assessment. However, all three types of adversity are likely to reflect
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24 325 a combination of underlying psychosocial need and environmental and social
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26 326 stressors.[34]
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29 327 Hospital interventions may reduce the risk of future harm, including the
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31 328 incidence of other types of harm not seen in hospital, e.g., further adversity-
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33 329 related injury not leading to admission. Further research using linked data
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35 330 from health care sectors such as accident and emergency, could shed light on
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37 331 the overall burden of adversity-related injury on hospitals. Such analyses are
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39 332 limited by the quality of accident and emergency data in England (available
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41 333 since 2007) and the resulting problems with identifying reasons for
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43 334 presentation and accurately linking individuals to long-term outcomes.[35]
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47 335 However, longitudinally-linked datasets in other countries could provide
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49 336 insights into long-term outcomes for this vulnerable group of adolescents.
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5 337 **Contributors**
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7 338 Annie Herbert – helped to conceive and design the study, analysed and
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9 339 interpreted the data, drafted the article, revised it critically for important
10
11 340 intellectual content and approved the final version to be published.

12
13
14 341 Leah Li – helped to conceive and design the study, interpreted the data,
15
16 342 revised the article critically for important intellectual content and approved the
17
18 343 final version to be published.

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20 344 Arturo González-Izquierdo – helped to conceive and design the study,
21
22 345 acquired and interpreted the data, revised the article critically for important
23
24 346 intellectual content and approved the final version to be published.

25
26
27 347 Ruth Gilbert – helped to conceive and design the study, acquired and
28
29 348 interpreted the data, revised the article critically for important intellectual
30
31 349 content and approved the final version to be published.

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36
37 352

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4
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6
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8
9
10 365 authors' work was independent of their funders.

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14 367 **Ethics** Both Hospital Episode Statistics (HES) admissions data and Office for
15
16 368 National Statistics (ONS) mid-year population estimates are derived from
17
18 369 routinely collected administrative data. HES data were pseudonymised
19
20
21 370 before we received them and therefore we did not require Research Ethics
22
23 371 Committee approval.

24
25 372

26
27 373 **Data sharing** No additional data on HES are available. ONS mid-year
28
29 374 population estimates may be accessed freely online:
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32 375 [http://www.ons.gov.uk/ons/publications/all-](http://www.ons.gov.uk/ons/publications/all-releases.html?definition=tcm%3A77-22371)
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34 376 [releases.html?definition=tcm%3A77-22371](http://www.ons.gov.uk/ons/publications/all-releases.html?definition=tcm%3A77-22371).

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8 1 **VictimisationViolence, self-harm and drug or alcohol misuse**
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10 2 **in adolescents admitted to hospitals in England for injury: a**
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36 15 Short title: Adversity in adolescents admitted to hospital for injury
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38 16 *Key words: Wounds and Injuries, Violence, Self-injurious Behaviour,*
39 17 *Substance-related Disorders, Adolescent*
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25 ABSTRACT

26 Objectives

27 Of adolescents in the general population in England, we aimed to determine
28 1) the proportion that has an emergency admission to hospital for injury
29 related to adversity (~~victimisation~~violence, self-harm or drug or alcohol
30 misuse) and 2) the risk of recurrent emergency admissions for injury in
31 adolescents admitted with adversity-related injury compared with those
32 admitted with accident-related injury only.

33 Design

34 We used longitudinally-linked hospital administrative hospital data (Hospital
35 Episode Statistics) to identify 10-19 year olds with emergency admissions for
36 injury (including day cases lasting more than four hours), in England in 1998-
37 2011. We used Office for National Statistics mid-year estimates for
38 population denominators.

39 Results

40 Approximately 4.3% (n=141 248) of adolescents in the general population
41 (n=3 254 046) had one or more emergency admissions for adversity-related
42 injury (~~140 512/3 254 046~~; girls 4.6%, boys 4.1%), accounting for 59.950.0%
43 of all emergency admissions for injury in girls and 29.61% in boys.
44 Admissions for self-harm or drug or alcohol misuse commonly occurred in the
45 same girls and boys. Recurrent emergency admissions for injury were more
46 common in adolescents with adversity-related injury (girls 17.3%; boys
47 16.57%) than in those with accident-related injury only (girls 54.7%; boys

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6 48 | 7.4%), particularly for adolescents with adversity-related injury related to
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8 49 | multiple types of adversity (girls 21.1%; boys 24.2%).
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10 **Conclusion**

11 Hospital-based interventions should be developed to reduce the risk of future
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14 52 | injury in adolescents admitted for adversity-related injury.
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53 What is already known on this subject

- 54 • Adolescents exposed to adversity (~~victimisation~~violence, self-harm or
55 drug or alcohol misuse) often use health services, and repetitively.
- 56 • Many adolescents in the general population are exposed to multiple
57 types of adversity during their adolescence.

59 What this study adds

- 60 • One in 20 adolescents in England has~~ve~~ an emergency admission to
61 hospital for adversity-related injury between 10 and 19 years old.
- 62 • Many adolescents admitted with adversity-related injury (particularly
63 girls) are admitted with multiple types of adversity, self-harm and drug
64 or alcohol misuse being the most common combination.
- 65 • Re~~_~~admission is more common in these adolescents than those
66 admitted with accident-related injury only.

68 Strengths and limitations of this study

- 69 • Hospital Episodes Statistics (HES) captured data on all admissions to
70 National Health Service hospitals in England at 10-19 years old in this
71 study's cohort.
- 72 • The longitudinal link between admissions for each individual in HES
73 data allowed us to study the burden of multiple emergency admissions
74 for injury over time.
- 75 • However, ~~victimisation~~violence, self-harm and drug or alcohol misuse
76 are not always recognised at an admission, or consistently recorded,

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6 77 and therefore this study's estimates of prevalence of adversity are
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8 78 likely to be underestimates.
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79 INTRODUCTION

80 Many adolescents exposed to adversity such as ~~victimisation~~
81 ~~violence(maltreatment or assault)~~, self-harm, or drug or alcohol misuse use
82 secondary health services,[1 2] often repetitively.[3 4] For example, in a self-
83 report survey of 15-16 year olds in England, 12.6% of those who had self-
84 harmed had presented to hospital.[2] It is also estimated that approximately
85 one-third of patients attending a hospital in England for self-harm re-attend for
86 self-harm in the following year.[4] Improved management of adolescents
87 exposed to adversity could reduce risk of repetition as well as the burden on
88 secondary care.[5-7]

89 An admission to hospital provides the 'teachable moment' ~~.[8].[8] where~~
90 ~~That is,~~ both adolescents and their families may be more likely to engage ~~with~~
91 an intervention than if they had received it elsewhere. Hospital-based
92 interventions to reduce the risk of future harm could benefit these adolescents
93 by reducing episodes of injury, and may reduce recurrent emergency (i.e.,
94 acute or unplanned) admissions for injury.

95 To date, there is a lack of evidence on how different types of
96 adversity-related injury occur in the same adolescents, over time. In addition,
97 policy makers and service providers need ~~to~~ know how many adolescents
98 have an emergency admission to hospital for adversity-related injury, their
99 characteristics and their specific rates of re-admission if they are to be
100 feasibly targeted for intervention.

101 In this study we used administrative hospital data and Office for
102 National Statistics (ONS) mid-year population estimates to estimate the
103 number of adolescents in the general population who ~~have~~ ever had ~~ve~~ an

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6 104 emergency admission to hospital for injury. We then estimated the
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8 105 prevalence of emergency admissions for injury related to
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10 106 ~~victimisation~~violence, self-harm and drug or alcohol misuse (alone and co-
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12 107 occurring) in the general population. Finally, we determined the risk of
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14 108 recurrent emergency admissions for injury in adolescents who had at least
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16 109 one admission between 10 and 19 years for adversity-related injury compared
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18 110 with adolescents only ever admitted for accidental injury during the same
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20 111 period.
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8 112 **METHODS**

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10 113 **Study population**

11 114 Using administrative data from all admissions to National Health Service
12 115 hospitals in England (Hospital Episode Statistics [HES]) in 1998-2011,[9] we
13 116 derived a retrospective cohort of adolescents who turned 10 years old in
14 117 1998-2002, who could be observed throughout adolescence until 19 years old
15 118 (Supplementary Table 1).[10] Each individual also had to have at least one
16 119 emergency admission for injury between 10 and 19 years old.

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25 120 **Admission data**

26 121 The Health and Social Care Information Centre provided pseudonymised data
27 122 on hospital admissions, use of which did not require Research Ethics
28 123 Committee approval.[11] An admission is defined by the National Health
29 124 Service as any hospital case lasting longer than four hours, and so includes
30 125 long day cases as well as overnight stays. We analysed any hospital
31 126 transfers or admissions within one day after discharge as the same
32 127 admission, as previously described.[12] We used the variable for method of
33 128 admission ('admimeth') to define an emergency admission. We used all
34 129 International Classification of Diseases-10 (ICD-10) diagnosis codes recorded
35 130 during an admission to categorise admissions as being for injury related to
36 131 adversity ~~or;~~ an accident ~~_ or other causes~~ (Supplementary Table 2).[13]

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49 132 **Types of injury and age at emergency admission**

50 133 We defined an emergency admission for injury as being ~~for~~-related to
51 134 adversity, comprising victimisation-violence

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6 135 | (maltreatment/assault/~~undetermined causes of injury~~), self-harm or drug or
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8 136 | alcohol misuse, using mutually exclusive clusters of ICD-10 codes
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10 137 | (Supplementary Table 2). ~~Violence~~ ~~timisation~~ was defined by previously-
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12 138 | validated codes, which would trigger consideration of ~~maltreatment-violence~~
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14 139 | by carers ~~or of assault, peers or strangers~~. [12 14 15] We defined self-harm
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16 140 | using codes that mentioned either 'self-harm' or 'self-poisoning', ~~and excluded~~
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18 141 | ~~'undetermined intent'~~. Drug or alcohol misuse was defined by codes that
19
20 142 | mentioned 'alcohol', 'drugs', 'noxious substance' or 'solvent'. ~~We considered~~
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22 143 | ~~alcohol use (Z72.1) to be misuse only in adolescents younger than 18.~~ We
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24 144 | defined an injury as being related to accidents only if no adversity codes were
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26 145 | present but there were codes from the ICD-10 *Accidents* subchapter (V01-
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28 146 | X59). [13]

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30 147 | We grouped age at each admission ~~as 10-14 years, 15-17 years and~~
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32 148 | ~~18-19 years~~, to reflect age of onset of puberty (10-14 years), age of sitting
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34 149 | secondary school exams (~~15-18~~ 15-17 years) and the legal age for buying
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36 150 | alcohol (18-19 years). [16-19]

151 **Classification of adolescents according to types of injury and age at** 152 **emergency admissions**

153 We classed adolescents into groups according to all of their emergency
154 admissions for injury between 10 and 19 years old. Adolescents were
155 classed as belonging to the '~~AdvR~~adversity' group (any adversity-related
156 injury between 10 and 19 years old), '~~AccR~~accidents Only' group (no
157 adversity-related injury but one or more accident-related injuries) or '~~o~~Other
158 Causes' group (no adversity-related or accident-related injuries)
159 (Supplementary Figure 1). Among adolescents in the ~~AdvR~~adversity group,

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6 160 we determined the proportion exposed to ~~victimisation-violence-~~, self-harm-
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8 161 and drug or alcohol misuse-related injury at age 10-19, respectively. We
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10 162 further classified the ~~Adversity~~ group into seven mutually exclusive sub-
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12 163 groups: ~~Victimisation-violence Only~~, ~~Selfself-harm Only~~, ~~Drug-drug~~ or
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14 164 ~~Alcohol-alcohol Misuse misuse Only (DA Only)~~, ~~Victimisation-violence~~ and
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16 165 ~~Selfself-harm (V+SH)~~, ~~Victimisation-violence~~ and ~~Drug-drug~~ or ~~Alcohol-alcohol~~
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18 166 ~~Mmisuse (V+DA)~~, ~~Selfself-harm~~ and ~~Drug-drug~~ or ~~Alcohol-alcohol Misuse~~
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20 167 ~~misuse, (SH+ DA)~~ and ~~Victimisation violence~~, ~~Selfself-harm~~ and ~~Drug-drug~~ or
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22 168 ~~Alcohol-alcohol Mmisuse (V+SH+DA)~~.

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24 169 We also grouped adolescents as above, according to their emergency
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26 170 admissions for injury at 10-14 years only, 15-17 years only and 18-19 years
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28 171 only (Supplementary Figure 2).

172 ~~Defining an adolescent as having a chronic condition~~

173 ~~We used a previously validated cluster of ICD-10 codes to identify~~
174 ~~adolescents who had been affected by a chronic condition in any admission~~
175 ~~between 10 and 19 years old (Supplementary Table 2).~~

176 **Population denominators**

177 We used ONS mid-year population estimates to derive population
178 denominators.[20 21] These data are freely available online broken down by
179 sex and year of age.

180 **Analyses**

181 We estimated the proportion of adolescents in the general population who had
182 an emergency admission for injury between 10 and 19 years old. ~~We, by~~
183 ~~using~~ the number of adolescents in our derived retrospective cohort as the

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6 184 numerator and ONS mid-year estimates for 10 year olds in 1998-2002 as the
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8 185 population denominator. We then calculated these proportions by types of
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10 186 injury at 10-19 years old (adversity-related [~~AdvR~~adversity group and seven
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12 187 mutually exclusive subgroups] and accidents only [~~AccR~~accidents Only-only
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14 188 group]) and by age group, as described above.

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16 189 We calculated the proportion of adolescents in the ~~AdvR~~adversity
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18 190 group (and subgroups) and in the ~~AccR~~accidents Only-only group, who had
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20 191 an emergency admission for injury twice and three or more times between 10
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22 192 and 19 years old. We also calculated the proportions of adolescents with two
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24 193 or three or more admissions of any type (including non-emergency and non-
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26 194 injury).

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28 195 We reported all results separately for girls and boys, since differences
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30 196 between girls and boys have been reported for prevalence of adversity in the
31
32 197 general population.[1 22-24] We calculated 95% confidence intervals for all
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34 198 proportions but did not present them [here](#) as they were all too narrow to
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36 199 convey any useful information (within one unit of the sample estimate).
37
38 200 Analyses were carried out in StataSE 12.

201 **RESULTS**

202 There were 1 033 702 adolescents in HES admissions data in 1998-2011, of
203 which 402 916 formed the study cohort (462 476 emergency admission for
204 injury when considering multiple presentations from the same adolescent, 802
205 682 admissions of any type [including non-emergency and non-injury 1,662
206 727 of which were overnight stays] (Table 1), representing 12.4% (402 916/3
207 254 046) of the adolescent population. Twice as many boys as girls had an
208 emergency admission for injury during adolescence (144 158/1 588 942 girls
209 in the population [8.7%]; 258 503/1 665 104 boys [16.3%]).

Table 1. Characteristics of adolescents ~~between 10 and 19 years old~~ whose entire ten years of adolescence (ages 10-19) occurred in 1998-2011.

Characteristics	Adolescent Population opulation*	Adolescents with emergency admission(s) for injury between 10 and 19 years old, n (row %)			
		Total	AdvRI Adversity	AccRI Accidents Only	Other Causes causes
All	3,254,046	402,916 (100.0)	141,248 140,512 (35.1) (34.9)	233,907 234,665 (58.1) (58.2)	27,761 27,739 (6.9) (6.9)
Age**					
Girls	1,588,942	144,158 (100.0)	72,805 72,768 (50.5) (50.5)	59,528 59,528 (41.3) (41.3)	11,888 11,862 (8.2) (8.2)
10-14 years	.	65,208 (100.0)	23,178 23,289 (35.5) (35.7)	37,388 37,303 (57.3) (57.2)	4,642 4,616 (7.1) (7.1)
15-17 years	.	48,286 (100.0)	31,573 31,620 (65.4) (65.5)	12,922 12,882 (26.8) (26.7)	3,791 3,784 (7.9) (7.8)
18-19 years	.	30,664 (100.0)	18,054 17,859 (58.9) (58.2)	9,155 9,343 (29.9) (30.5)	3,455 3,462 (11.3) (11.3)
Boys	1,665,104	258,503 (100.0)	68,403 67,704 (26.5) (26.2)	174,267 174,962 (67.4) (67.7)	15,833 15,837 (6.1) (6.1)
10-14 years	.	121,821 (100.0)	17,667 17,660 (14.5) (14.5)	97,478 97,511 (80.0) (80.0)	6,676 6,650 (5.5) (5.5)
15-17 years	.	79,223 (100.0)	25,014 25,004 (31.6) (31.6)	49,345 49,366 (62.3) (62.3)	4,864 4,853 (6.1) (6.1)
18-19 years	.	57,459 (100.0)	25,722 25,040 (44.8) (43.6)	27,444 28,085 (47.8) (48.9)	4,293
Missing (Sex)	.	255 (100.0)	404 40 (15.7) (15.7)	175 175 (68.6) (68.6)	404 40 (15.7) (15.7)
		Adolescents with emergency admission(s) for injury between 10 and 19 years old, n (column %)			
		Total	AdvRI	AccRI Only	Other Causes

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All	3,254,046	402,916 (100.0)	140,512 (100.0)	234,665 (100.0)	27,739 (100.0)
Chronic Condition	-	117,190 (29.0)	47,001 (33.4)	52,509 (22.4)	16,706 (60.0)

213 ~~AdvRI = Adversity-related Injury, AccRI Only = Accident-related Injury Only.~~
 214 ~~*Adolescents whose entire ten years of adolescence (ages 10-19) occurred in 1998-2011.~~
 215 *Based on ONS mid-year England statistics for 10 year olds in 1998-2002.[20]
 216 **At first emergency admission for injury

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217 **Types of injury and age at emergency admission**

218 One-third of the cohort (~~140-152~~141 248, 4.3% of the population) had a record
 219 of an emergency admission for adversity-related injury between 10 and 19
 220 years old (the ~~AdvR~~adversity group; ~~1537 633-004~~ emergency admissions for
 221 adversity-related injury in total) (Table 1), with similar rates between sexes (72
 222 ~~768805~~, 4.36% girls in the population; ~~67-704~~68 403, 4.1% boys).

223 The remaining two-thirds of the cohort (~~2621 404,668~~, 8.1% of the
 224 adolescent population) had emergency admissions for injury which were
 225 never related to adversity (Table 1). Among these adolescents, ~~2343 665-907~~
 226 (89.4%) had an accident-related injury (the ~~AccR~~accidents Only-only group,
 227 7.2% of the population) and ~~27 739-761~~ (10.6%) had no accident-related
 228 injury (~~Other-other Causes-causes~~ group, 0.9% of the population). A higher
 229 proportion of the ~~Other-other Causes-causes~~ group were affected by a chronic
 230 condition¹ between 10 and 19 years old (~~46-706~~11 221/27 739761, 6040.4%),
 231 compared with the ~~AdvR~~adversity group (~~47-001/140-54245 321/141 248~~,
 232 32.13%) or ~~AccR~~accidents Only-only group (~~52-50949 434/234-665233 907~~,
 233 2221.1%).

234 Proportions of adolescents in the general population and within
 235 individual age groups by These groupings (AdvRadversity [and subgroups],
 236 AccRaccidents only, Other and other Causescauses groups) are provided in
 237 Supplementary Table 3, ~~as proportions of adolescents in the general~~
 238 ~~population and within individual age groups.~~

¹ Defined by ICD-10 codes (Supplementary Table 2)

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6 239 **Types of adversity-related injury**
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8 240 Among adolescents in the [Adversity](#) group (girls 72 ~~768805~~, boys
9 ~~67,70468 403~~) (Figure 1), the most common type of adversity was drug or
10 241 ~~67,70468 403~~ (Figure 1), the most common type of adversity was drug or
11 242 alcohol misuse (girls 91.54%, boys ~~5860.0~~%). A higher proportion of boys
12 243 than girls were exposed to [victimisation-violence](#) (girls 178.5%, boys
13 244 ~~51.747.6~~%), but a higher proportion of girls than boys were exposed to self-
14 245 harm (girls 74.6%; boys ~~31.032.9~~%).
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Girls in the **AdvRI** **adversity** group were most likely to be exposed to multiple types of adversity between 10 and 19 years old (69.2% + 2.0% + 1.2% + 0.2% = 72.6%) (Figure 1), especially **SH+DA** **self-harm and drug or alcohol misuse** (61.769.2% of the entire adversity group, i.e., most of the 732.6%). Fewer boys in the **AdvRI** **adversity** group were exposed to multiple types of adversity (36.238.4%), the most common combination also being **SH+DA** **self-harm and drug or alcohol misuse** (22.724.8%).

For most of the adolescents who **were** exposed to multiple types of adversity, the combination of types was recorded at the same admission. For example, among the 352-130 adolescent girls who were exposed to **victimisation-violence** and self-harm between 10 and 19 years old (**Figure 4** **Table 2**), 85.364.6% had both **violence** **victimisation** and self-harm codes present simultaneously **in** at least one emergency admission for injury (**violence and drug or alcohol misuse** **V+DA** 86.178.8%, **SH+DA** **self-harm and drug or alcohol misuse** 99.7%, **V+SH+DA** **violence, self-harm and drug or alcohol misuse** 83.233.9%; boys: **V+SH** **violence and self-harm** 63.240.1%, **violence and drug or alcohol misuse** **V+DA** 84.51%, **self-harm and drug or alcohol misuse** **SH+DA** 99.10%, **violence, self-harm and drug or alcohol misuse** **V+SH+DA** 59.120.0%) (data not shown).

Emergency readmissions for injury

Adolescent girls in the **AdvRI** group (50.5% of all girls in the cohort) accounted for 59.9% of the total number of emergency admissions for injury coming from girls (data not shown), compared with girls in the **AccRI Only** group (41.3% of all girls) who accounted for 15.1%. Boys in the **AdvRI** group (26.2% of all

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6 270 | boys in the cohort) accounted for 29.6% compared with 61.7% contributed by
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8 271 | boys in the AccRI Only group (67.7% of all boys).
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10 272 | More adolescents in the AdvRI group were readmitted for injury (i.e.,
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12 273 | had two or more emergency admissions for injury) between 10 and 19 years
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14 274 | old (both girls and boys 17%) (Figure 2), than in the AccRI Only group (girls
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16 275 | 5%; boys 7%). Among adolescents admitted for AdvRIs related to multiple
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18 276 | types of adversity (Table 2), the proportion readmitted was even higher
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20 277 | (multiple types: girls 21%, boys 24%; single type: girls 7%, boys 12%).
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278 **Table 2.** Proportion of adolescents ~~s girls and boys~~ with 1, 2 or 3+ emergency admission(s) for injury or 1, 2 or 3+ admission(s) of
 279 any type, by types of adversity between 10 and 19 years old*

Adolescent group*	No. girls	Girls (%)						Boys (%)						
		Emergency admission(s) for injury			Admission(s) of any type			Emergency admission(s) for injury			Admission(s) of any type			
		1	2	3+	1	2	3+	No. boys	1	2	3+	1	2	3+
All	144,158	88.688.6	8.38.3	3.13.4	57.657.6	20.520.5	22.022.0	258,503	90.390.3	8.08.0	1.84.8	68.568.5	18.748.7	12.942.9
Any Adversity	72,80572,768	82.782.6	12.042.0	5.35.3	53.853.8	21.121.0	25.125.2	68,40367,704	83.583.4	12.442.5	4.14.4	64.864.7	19.449.4	15.845.9
Any Violence	6,21142,740	77.273.4	13.945.7	8.944.2	49.146.7	20.724.0	30.132.3	32,79935,003	83.282.6	12.842.9	4.04.5	65.664.9	19.649.4	14.845.7
Any Self-harm	54,31554,315	79.379.3	13.943.9	6.86.8	51.251.2	21.521.5	27.327.3	21,08721,087	76.776.7	15.845.8	7.57.5	57.057.0	20.720.7	22.322.3
Any Drug or alcohol Misuse	66,64566,255	81.984.8	12.542.5	5.65.7	53.653.5	21.124.4	25.325.4	41,01439,264	81.180.9	13.643.7	5.35.4	62.962.6	19.549.6	17.647.8
Single adversity	19,92419,194	92.892.9	6.26.4	1.04.0	61.261.2	19.849.6	19.049.2	43,56343,244	71.387.6	8.340.2	1.82.2	55.868.5	15.248.8	10.342.8
Violence Only	3,7344,047	92.494.8	6.36.7	1.34.5	58.157.6	20.420.2	21.622.2	24,91225,908	87.187.0	10.640.7	2.22.3	68.368.4	19.249.2	12.642.7
Self-harm Only	2,2962,444	90.390.8	8.17.7	1.64.5	54.454.4	20.720.8	24.924.8	2,2602,488	87.387.6	10.440.0	2.32.4	62.362.8	19.849.6	12.642.7
Drug or Alcohol misuse Only	13,89413,033	93.393.5	5.95.7	0.80.8	63.263.4	19.549.3	17.447.3	16,39145,448	88.588.5	9.59.4	2.12.4	69.969.9	17.947.9	12.242.2

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	Adolescent group*	No. girls	Girls (%)						Boys (%)						
			Emergency admission(s) for injury			Admission(s) of any type			Emergency admission(s) for injury			Admission(s) of any type			
			1	2	3+	1	2	3+	No. boys	1	2	3+	1	2	3+
	Multiple adversity	52,881	78.979	14.214	6.969	51.051	21.621	27.427	24,840	77.376	16.716	7.575	59.058	21.020	21.521
	V + SH	130,352	70.080	20.814	9.248	42.349	26.223	31.527	217,344	41.671	15.421	6.164	32.853	16.024	14.221
	V + DA	862,137	81.984	15.113	3.023	52.254	22.922	24.923	6,013	84.678	17.516	5.453	68.463	21.820	17.316
	SH + DA	50,404	80.184	13.713	6.354	51.852	21.624	26.625	16,953	86.779	16.414	6.955	64.659	22.724	22.919
	V + SH + DA	1,485	36.859	31.621	31.519	25.538	19.921	54.540	1,657	22.054	16.424	14.121	17.943	11.719	22.837
	No adversity	71,353	94.794	4.545	0.808	61.461	19.919	18.718	190,100	92.492	6.364	0.909	69.569	18.318	11.811
	Accidents only	59,465	95.395	4.114	0.606	66.566	18.718	14.714	174,267	92.392	6.565	0.909	71.171	18.018	10.510
	Other causes	11,888	91.591	6.363	2.121	35.535	25.825	38.838	15,833	93.493	5.050	1.616	51.551	22.122	26.326

280 V = Victimization/Violence, SH = Self-harm, DA = Drug or Alcohol Misuse, AdvRI = Adversity-related Injury, AccRI Only = Accident-related Injury Only.
 281 * Each adolescent classified by all adversities/accidents seen at any emergency admission(s) for injury between 10 and 19 years old.

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7 282 Emergency re-admissions for injury

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9 283 Adolescent girls in the adversity group (50.5% of all girls in the cohort)

10 284 accounted for 50.0% of the total number of emergency admissions for injury

11 285 coming from girls (data not shown), compared with girls in the accidents only

12 286 group (41.3% of all girls) who accounted for 36.6%. Boys in the adversity

13 287 group (26.2% of all boys in the cohort) accounted for 29.1% compared with

14 288 65.0% contributed by boys in the accidents only group (67.7% of all boys).

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21 289 More adolescents in the adversity group were re-admitted for injury

22 290 (i.e., had two or more emergency admissions for injury) between 10 and 19

23 291 years old (girls 17.3%, boys 16.5%) (Figure 2), than in the accidents only

24 292 group (girls 4.7%; boys 7.4%). Among adolescents admitted for injuries

25 293 related to multiple types of adversity (Table 2), the proportion re-admitted was

26 294 even higher (multiple types: girls 21.1%, boys 24.2%; single type: girls 7.2%,

27 295 boys 10.1%).

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34 296 Similarly, a higher proportion of adolescents in the Adversity

35 297 group had two more admissions of any type (including non-emergency and

36 298 non-injury) between 10 and 19 years old (girls 43.2%; boys 35.2%); (Table

37 299 2) compared with adolescents in the Accidents Only group (girls

38 300 33.4%; boys 28.5%). This proportion was even higher for adolescents in the

39 301 Adversity group who were admitted with multiple types of adversity

40 302 (multiple types: girls 48.8%, boys 42.5%; single type: girls 38.8%, boys

41 303 34.6%).

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6 304 **DISCUSSION**

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8 305 More than one in 20 adolescents in England had at least one emergency
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10 306 admission for adversity-related injury between 10 and 19 years old. These
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12 307 adolescents accounted for a third of all adolescents with emergency
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14 308 admissions for injury and for a disproportionate number of re-admissions for
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16 309 injury, particularly adolescents admitted with multiple types of adversity-
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18 310 related injury. Targeting adolescents admitted with adversity-related injury
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20 311 could reduce their risk of future harm, ~~and~~ the rate of re-admissions to
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22 312 hospital, ~~and, which could reduce health care some of the most expensive~~
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24 313 ~~types of healthcare and the UK government is keen to reduce costs~~. [25]

25
26 314 Longitudinally-linked admissions allowed us to study the entire ten
27
28 315 years of adolescence in 402 916 ~~adolescents~~ individuals. ~~We were able~~, to
29
30 316 distinguish between types of adversity that co-occurred during adolescence or
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32 317 at the same admission, and to study re-admissions.

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34 318 One weakness of this study was our reliance on diagnostic codes
35
36 319 recorded in administrative data. ~~Violence by carers, which could be coded~~
37
38 320 ~~under maltreatment, Maltreatment~~ and drug or alcohol misuse have been
39
40 321 shown to be under-recorded using ICD-10, [26 27] but false positives are
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42 322 rare. [15] To address under-recording, we used what we considered to be
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44 323 sensitive clusters of codes for adversity. Other factors related to recording or
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46 324 coding practices, [12 14 15 27 28] for example, new guidelines for defining
47
48 325 maltreatment, [14] can also affect ascertainment. Because of the relative
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50 326 insensitivity but good specificity of the coding clusters, some adolescents who
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52 327 were classified in the ~~AccR~~ accidents only group may in fact belong to the
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54 328 ~~AdvR~~ adversity group, but did not have their adversity recognised or recorded.

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6 329 Consequently, our prevalence estimates of admission for different types of
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8 330 adversity-related injury are likely to provide a lower bound for the true
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10 331 prevalence.

11 332 Our prevalence estimates of admission for injury related to individual
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13 333 types of adversity from the general adolescent population are consistent with
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15 334 previous reports for emergency admissions for assault-related injury in 2004-
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17 335 2009 and for all admissions (emergency and non-emergency) for self-harm
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19 336 and drug or alcohol misuse.[1 2 24 29] Previous studies have reported higher
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21 337 rates of drug or alcohol misuse in boys than in girls in the general adolescent
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23 338 population.[24] We found higher rates in girls. This difference could indicate
24
25 339 that girls exposed to drug or alcohol misuse are more likely to be injured, to
26
27 340 present to hospital, or to be admitted after a hospital presentation, than boys
28
29 341 be admitted after presenting to hospital, as a result.

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31 342 Our estimated rates of re-admission of any type (including non-
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33 343 emergency and non-injury) for victimisation violence (girls 53.350.8%, boys
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35 344 35.134.4%) (Table 2) and self-harm (girls 48.8%, boys 43.0%) were higher
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37 345 than previously reported (11% for victimisation violence, 33% for self-harm).[3
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39 346 4] These discrepancies are likely to be because we considered the whole ten
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41 347 years of adolescence and re-admission of any type, whereas previous studies
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43 348 looked at re-attendance up to the following year and for the same type of
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45 349 adversity-related injury.[3 4]

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47 350 The results of this study should inform policy initiatives and national
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49 351 guidelines. Firstly, a substantial proportion of adolescents are affected by
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51 352 adversity and they account for a large proportion (29.6-1 to -509.09%) of all
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53 353 emergency admissions to hospital for injury in this age group. Secondly, we

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6 354 show the large burden of injury admission for all three types of adversity, yet
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8 355 there are currently no national clinical guidelines for managing cases of
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10 356 assault violence, other than responding to violence by caregivers.^[30] Finally,
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12 357 these results show that adolescents often present with multiple types of
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14 358 adversity (especially in girls), even though guidelines exist only for managing
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16 359 individual problems.^[31-33]

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18 360 In addition, policy makers need to be aware of the widely varying
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20 361 aetiological pathways to admission with adversity-related injury. Our
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22 362 approach to defining this group of adolescents is not designed to reflect the
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24 363 complexity or severity of these cases. For example, admission for multiple
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26 364 types of adversity-related injury is a poor proxy indicator of severity. Effective
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28 365 interventions will need to be tailored to the individual, based on specialist
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30 366 clinical assessment. However, all three types of adversity are likely to reflect
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32 367 a combination of underlying psychosocial need and environmental and social
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34 368 stressors.^[34] This intervention

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36 369 Hospital interventions may reduce the risk of future harm, including the
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38 370 incidence of other types of harm not seen in hospital, e.g., further adversity-
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40 371 related injury not leading to admission, that are likely to be more frequent in
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42 372 these adolescents, and which the hospital administrative data we used does
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44 373 not capture. Further research using work in admissions-linked data linked
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46 374 from to other administrative datasets, e-health care sectors such asg,
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48 375 accident and emergency data, could tell us if the risk of these other types of
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50 376 harm is also increased in adolescents admitted with adversity-related
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52 377 injury could shed light on the overall burden of adversity-related injury on
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54 378 hospitals. this, as well as, tell us whether the risk of future harm is increased in

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6 379 adolescents who attend hospital with adversity related injury but are not
7 admitted. Such analyses are limited by the quality of Such work in England
8 380 would be challenging, as accident and emergency data in England (available
9 381 since 2007) and the resulting problems with identifying reasons for
10 382 presentation and accurately linking individuals to long-term outcomes are
11 383 much sparser than national admissions data and have only been collected
12 384 since 2007^[35] However, Existing longitudinally-linked datasets in other
13 385 countries could provide insights into long-term outcomes for this vulnerable
14 386 group of adolescents.
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8 388 **Contributors**

9
10 389 | Annie Herbert — helped _to conceive and design the study, analysed and
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12 390 | interpreted the data, drafted the article, revised it critically for important
13
14 391 | intellectual content and approved the final version to be published.

15
16 392 | Leah Li — helped _to conceive and design the study, interpreted the data,
17
18 393 | revised the article critically for important intellectual content and approved the
19
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21
22 395 | Arturo González-Izquierdo — helped _to conceive and design the study,
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24 396 | acquired and interpreted the data, revised the article critically for important
25
26 397 | intellectual content and approved the final version to be published.

27
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29
30 399 | interpreted the data, revised the article critically for important intellectual
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9
10 415 manuscript or the decision to submit the paper for publication, and the
11
12 416 authors' work was independent of their funders.
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16 418 **Ethics** Both Hospital Episode Statistics (HES) admissions data and Office for
17
18 419 National Statistics (ONS) mid-year population estimates are derived from
19
20 420 routinely collected administrative data. HES data were pseudonymised
21
22 421 before we received them and therefore we did not require Research Ethics
23
24 422 Committee approval.
25

26 423

27
28 424 **Data sharing** No additional data on HES are available. ONS mid-year
29
30 425 population estimates may be accessed freely online:

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32 426 [http://www.ons.gov.uk/ons/publications/all-](http://www.ons.gov.uk/ons/publications/all-releases.html?definition=tcm%3A77-22371)

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34 427 [releases.html?definition=tcm%3A77-22371](http://www.ons.gov.uk/ons/publications/all-releases.html?definition=tcm%3A77-22371).
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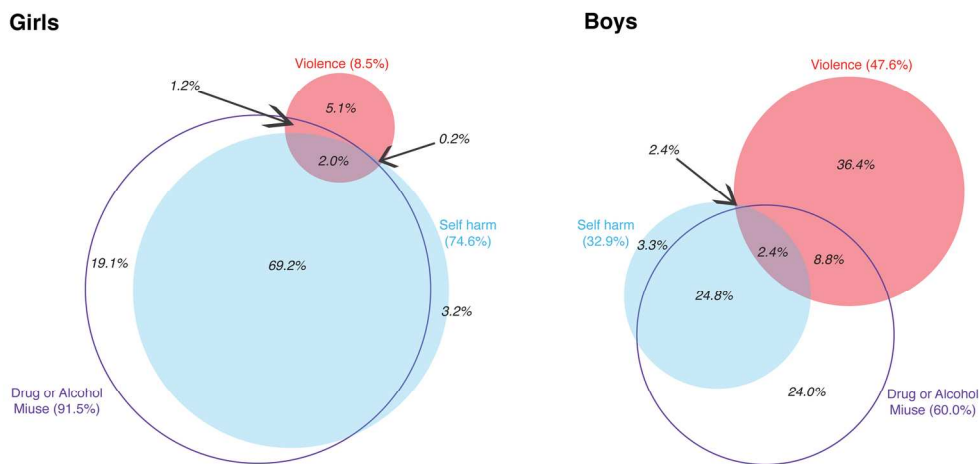
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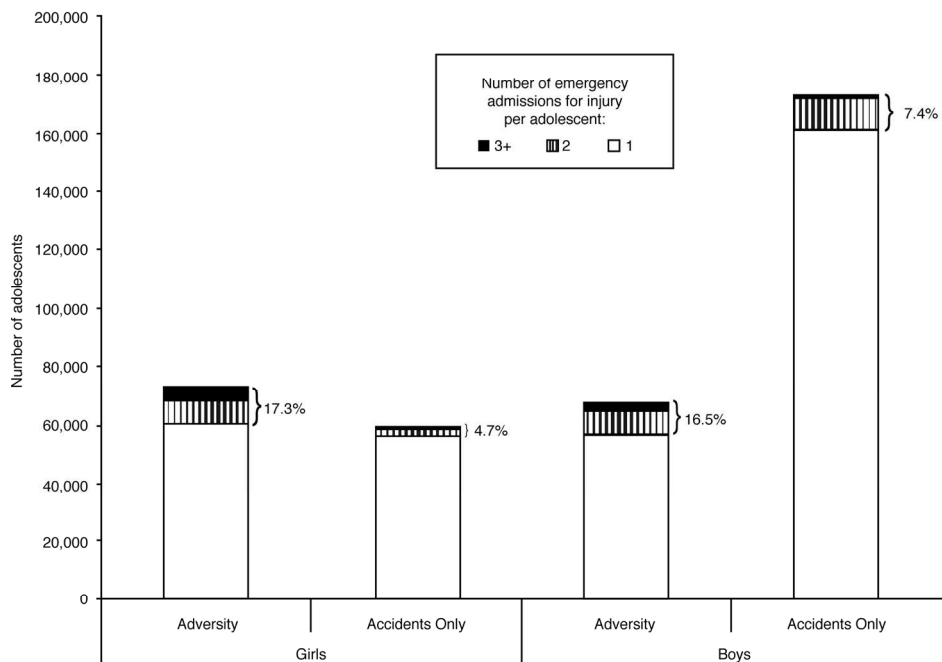


Number (%) of adolescents with adversity-related injury, by types of adversity between 10 and 19 years old* and sex

*Each adolescent classified by all adversity recorded at any emergency admission(s) for injury between 10 and 19 years old
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Number of adolescents with 1, 2 and 3 or more emergency admission(s) for injury between 10 and 19 years old*, by types of injury between 10 and 19 years old** and sex

*Percentages are of adolescents who have 2 or more emergency admissions for injury between 10 and 19 years old

**Each adolescent was classified by all adversity/accidents recorded at any emergency admission(s) for injury
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Supplementary Tables

Supplementary Table 1. Cohort (shaded) who have at least one emergency admission for injury between 10 and 19 years old in 1998-2011 (N = 402,916)

1998	1999	2000	2001	2002	...	2007	2008	2009	2010	2011
6	7	8	9	10	...	15	16	17	18	19
7	8	9	10	11	...	16	17	18	19	20
8	9	10	11	12	...	17	18	19	20	21
9	10	11	12	13	...	18	19	20	21	22
10	11	12	13	14	...	19	20	21	22	23

Supplementary Table 2. Definitions and International Classification of Diseases (ICD-10) diagnostic codes used to classify emergency admissions for injury, chronic conditions and types of adversity*

ADMISSIONS AND ADMISSION TYPES

Admission

Admissions were defined by linked episodes of inpatient care, including day cases (any case > 4 hours stay). Any admission which occurred within one day or was a hospital transfer from a previous admission was considered to be the same admission. An episode may have up to 20 diagnosis codes entered, but 88% of admissions in this cohort had episodes with four or less diagnoses recorded (data not shown).

Emergency (acute; unplanned) admission

An admission was considered to be an emergency if the method of admission variable ('admimeth') was 21-24 or 28.(1)

Injury

An admission was considered to be for injury if any of the diagnosis codes in the first episode of the admission were S or T codes (Chapter XIX of the ICD -10).

CHRONIC CONDITIONS

ICD-10 codes as per Hardelid et al, 2013,(2) excluding E24.4, F10-F19, G31.2, G40.5, G62.1, G72.1, K29.2, K70, K85.2, K86.0, O35.4, R78.1-R78.5, Z50.2, Z50.3, Z86.4, X64-X84, Y10-Y34, Z91.5, F30.0-F30.2, F30.8-F32.3, F32.8-F334, F33.8-F34.1, F34.8-F34.9, F38.0-F38.1, F38.8, F39-F40.2, F40.8- F41.3, F41.8-F41.9.

ADVERSITY CLUSTERS AND DESCRIPTIONS*

ICD-10 CODES

Violence

Maltreatment

Maltreatment syndromes

T74

Effects of other deprivation (extreme neglect)

T73

Perpetrator of neglect and other maltreatment syndromes

Y06, Y07

Assault

Assault by bodily force and sexual assault

Y04, Y05

Other types of assault

X85 - Y03, Y08 - Y09

Undetermined cause

Events of undetermined intent

Y20 - Y34

Examination and observation following other inflicted injury

Z04.5

Examination and observation for other reasons: request

Z04.8

for expert evidence

Self-harm

Intentional self-poisoning by and exposure to...

...drugs

X60-X63

...other and unspecified drugs, medicaments and

X64

biological substances

...alcohol

X65

...organic solvents and halogenated hydrocarbons and

X66

their vapours

...other gases and vapours

X67

...pesticides

X68

...other and unspecified chemicals and noxious

X69

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3	substances	
4	<i>Intentional self-harm by...</i>	
5	...hanging, strangulation and suffocation	X70
6	...drowning and submersion	X71
7	...firearm discharge	X72-X74
8	...explosive material	X75
9	...smoke, fire and flames, or steam, hot vapours and hot	
10	objects	X76-X77
11	...sharp/blunt objects	X78-X79
12	...jumping from a high place	X80
13	...jumping or lying before a moving object, or crashing a	
14	motor vehicle	X81-82
15	...other specified means	X83
16	...unspecified means	X84
17	<i>Personal history of self-harm</i>	Z91.5
18		
19		
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21	Drug or alcohol misuse	
22	<i>Drugs, medicaments and biological substances (illicit drugs)</i>	
23	Mental and behavioural disorders due to psychoactive	
24	substance use	F11 - F17, F19
25	Finding of drugs not normally found in blood	R78.1 - R78.5
26	Poisoning by drugs, medicaments and biological	T36 - T50
27	substances	(not including T50.6)
28	Poisoning, undetermined intent	Y10 - Y14
29	Drug rehabilitation	Z50.3
30	Drug abuse counselling and surveillance	Z71.5
31	Drug use	Z72.2
32	<i>Environmental/ Domestic substances</i>	
33	Mental and behavioural disorders due to use of volatile	
34	solvents	F18
35	Accidental poisoning by and exposure to noxious	
36	substances	X40 - X44, X46 - X49
37	Intentional self-poisoning by and exposure to noxious	
38	substances	X69
39	Poisoning by chemical or noxious substance,	
40	undetermined intent	Y16 - Y19
41	<i>Codes mentioning both alcohol and drugs</i>	
42	Special epileptic syndromes - (related to alcohol, drugs,	
43	etc.)	G40.5
44	Blood-alcohol and blood-drug test	Z04.0
45	<i>Alcohol</i>	
46	Alcohol-induced pseudo-Cushing's syndrome	E24.4
47	Mental and behavioural disorders due to use of alcohol	F10
48	Degeneration of nervous system due to alcohol	G31.2
49	Alcoholic polyneuropathy	G62.1
50	Alcoholic myopathy	G72.1
51	Alcoholic cardiomyopathy	I42.1
52	Alcoholic gastritis	K29.2
53	Alcoholic liver disease	K70
54	Alcohol-induced acute pancreatitis	K85.2
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3	Alcohol-induced chronic pancreatitis	K86.0
4	Maternal care for (suspected) damage to fetus from	
5	alcohol	O35.4
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8	Finding of alcohol in blood	R78.0
9	Poisoning: antidotes and chelating agents, not elsewhere	
10	classified	T50.6
11	Toxic effect of alcohol	T51
12	Accidental poisoning by exposure to alcohol	X45
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15	Poisoning by exposure to alcohol, undetermined intent	Y15
16	Evidence of alcohol involvement determined by blood	
17	alcohol level	Y90
18	Evidence of alcohol involvement determined by level of	
19	intoxication	Y91
20	Alcohol rehabilitation	Z50.2
21	Alcohol abuse counselling and surveillance	Z71.4
22	Alcohol use	Z72.1
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25	Accidents	
26	Transport accidents	V01 - V99
27	Falls	W00 - W19
28	Exposure to inanimate mechanical forces	W20 - W49
29	Exposure to animate mechanical forces	W50 - W64
30	Accidental drowning and submersion	W65 - W74
31	Other accidental threats to breathing	W75 - W84
32	Exposure to electric current, radiation and extreme	
33	ambient air temperature and pressure	W85 - W99
34	Exposure to smoke, fire and flames	X00 - X09
35	Contact with heat and hot substances	X10 - X19
36	Contact with venomous animals and plants	X20 - X29
37	Exposure to forces of nature	X30 - X39
38	Accidental poisoning by and exposure to noxious	
39	substances	X40 - X49
40	Overexertion, travel and privation	X50 - X57
41	Accidental exposure to other and unspecified factors	X58 - X59
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Supplementary Table 3. Population prevalence* (per 100,000) of emergency admission(s) for injury, by types of adversity within age periods** and sex

	All girls	All boys	Girls			Boys		
Adolescent group**	10-19y	10-19y	10-14y	15-17y	18-19y	10-14y	15-17y	18-19y
All	9,073	16,333‡	4,104	3,260§	2,189§	7,316‡	5,069‡§	3,852‡§
Adversity	4,582	4,108‡	1,240	2,124§	1,329§	669‡	1,458‡§	1,748‡§
Any violence	391	1,970‡	103	152§	110	277‡	731‡§	833‡§
Any self-harm	3,418	1,266‡	777	1,463§	923§	170‡	393‡§	478‡§
Any drug or alcohol misuse	4,194	2,463‡	1,112	1,959§	1,221§	375‡	807‡§	1,077‡§
Single adversity	1,254	2616‡	495	687§	412§	516	991‡§	1,114‡§
Violence only	235	1,496‡	77	99§	75	256‡	609‡§	635‡§
Self-harm only	144	136	48	63§	31§	37‡	39	34
Drug or alcohol misuse only	874	984‡	369	525§	305§	224‡	342‡§	445‡§
Multiple adversity	3,328	1,492‡	745	1,436§	917§	153‡	467‡§	634‡§
V+SH	8	13‡	3	3	1§	1‡	2	2
V+DA	54	361‡	17	37§	26§	19	114‡§	190‡§
SH+DA	3,172	1,018‡	720	1,384§	882§	131‡	345‡§	436‡§
V+SH+DA	93	100‡	6	13§	8	2‡	5‡§	6§
No adversity	4,491	11,417‡	2,676	1,136§	860§	6,648‡	3,611‡	2,171‡§
Accidents only	748	10,466‡	2,221	804§	580§	5,887‡	3,109‡	1,784‡§
Other causes	3,742	951‡	455	332§	279§	761‡	503‡	388‡§

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7 V = Violence, SH = Self-harm, DA = Drug or Alcohol Misuse

8 *Due to large denominators, confidence intervals for population prevalence were too narrow to provide any meaningful
9 interpretation and so are not shown.

10 **Each adolescent classified by all adversity/accidents seen at any emergency injury admission(s) at 10-19 years, 10-14 years, 15-
11 17 years and 18-19 years, respectively.

12 ‡Statistically significantly different from girls of the same age (according to 95% confidence intervals).

13 §Statistically significantly different from 10-14 year olds of the same sex (according to 95% confidence intervals).
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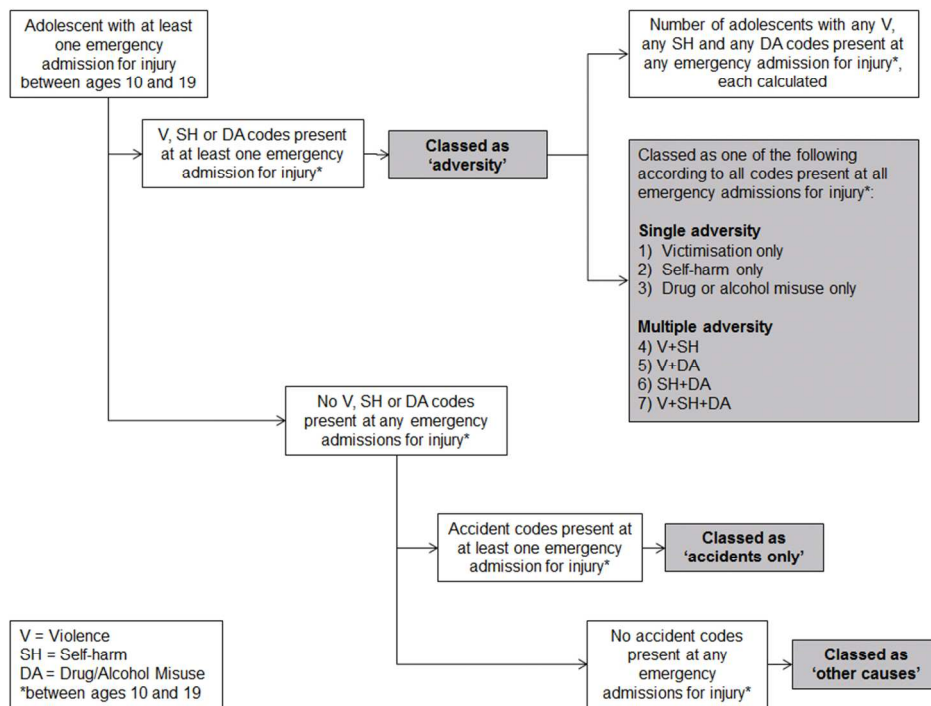
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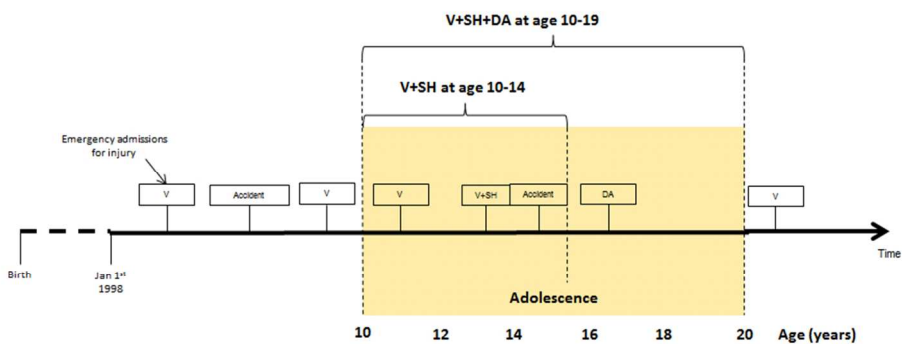


Classification of groups of adolescents

*between ages 10 and 19

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Supplementary Figure 2. Example of classification of groups of adolescents within age groups and across adolescence (ages 10-19).

V = victimisation, SH = self-harm, DA = drug or alcohol misuse.
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Supplementary Tables

Supplementary Table 1. Cohort (shaded) who have at least one emergency admission for injury between 10 and 19 years old in 1998-2011 (N = 402,916)

1998	1999	2000	2001	2002	...	2007	2008	2009	2010	2011
6	7	8	9	10	...	15	16	17	18	19
7	8	9	10	11	...	16	17	18	19	20
8	9	10	11	12	...	17	18	19	20	21
9	10	11	12	13	...	18	19	20	21	22
10	11	12	13	14	...	19	20	21	22	23

Supplementary Table 2. Definitions and International Classification of Diseases (ICD-10) diagnostic codes used to classify emergency admissions for injury, chronic conditions and types of adversity*

ADMISSIONS AND ADMISSION TYPES

Admission

Admissions were defined by linked episodes of inpatient care, including day cases (any case > 4 hours stay). Any admission which occurred within one day or was a hospital transfer from a previous admission was considered to be the same admission. An episode may have up to 20 diagnosis codes entered, but 88% of admissions in this cohort had episodes with four or less diagnoses recorded (data not shown).

Emergency (acute; unplanned) admission

An admission was considered to be an emergency if the method of admission variable ('admission') was 21-24 or 28.(1)

Injury

An admission was considered to be for injury if any of the diagnosis codes in the first episode of the admission were S or T codes (Chapter XIX of the ICD -10).

CHRONIC CONDITIONS

ICD-10 codes as per Hardelid et al, 2013,(2) excluding E24.4, F10-F19, G31.2, G40.5, G62.1, G72.1, K29.2, K70, K85.2, K86.0, O35.4, R78.1-R78.5, Z50.2, Z50.3, Z86.4, X64-X84, Y10-Y34, Z91.5, F30.0-F30.2, F30.8-F32.3, F32.8-F334, F33.8-F34.1, F34.8-F34.9, F38.0-F38.1, F38.8, F39-F40.2, F40.8- F41.3, F41.8-F41.9.

ADVERSITY CLUSTERS AND DESCRIPTIONS*

ICD-10 CODES

Victimisation

Violence	
<i>Maltreatment</i>	
Maltreatment syndromes	T74
Effects of other deprivation (extreme neglect)	T73
Perpetrator of neglect and other maltreatment syndromes	Y06, Y07
<i>Assault</i>	
Assault by bodily force and sexual assault	Y04, Y05
Other types of assault	X85 - Y03, Y08 - Y09
<i>Undetermined cause</i>	
Events of undetermined intent	Y20 - Y34
Examination and observation following other inflicted injury	Z04.5
Examination and observation for other reasons: request for expert evidence	Z04.8
— Adverse social circumstances	
— Neonatal withdrawal symptoms from maternal use of drugs of addiction	P96.1
— Other problems related to physical environment	Z58.8
— Problem related to physical environment, unspecified	Z58.9
— Homelessness	Z59.0
— Inadequate housing	Z59.1
— Lack of adequate food	Z59.4
— Extreme poverty	Z59.5
— Insufficient social insurance and welfare support	Z59.7
— Problem related to housing and economic circumstances, unspecified	Z59.9

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6	—Problems related to social environment	Z60
7	—Problems related to negative life events in childhood	Z61
8	—Other problems related to upbringing	Z62
9	—Other problems related to primary support group	Z63
10	—Discord with counsellors	Z64.4
11	—Problems related to other legal circumstances	Z65.3
12	—Other specified problems related to psychosocial	Z65.8
13	circumstances	
14	—Problem related to unspecified psychosocial	Z65.9
15	circumstances	
16	—Problems related to lifestyle	Z72.3—Z72.9
17	—Problems related to care provider dependency	Z74
18	—Health supervision and care of foundling	Z76.1
19	—Health supervision and care of other healthy infant and	Z76.2
20	child	
21	—Family history of mental and behavioural disorders	Z81
22	—Personal history of other specified risk factors, not	Z91.8
23	elsewhere classified	

Self-harm

24		
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26	<i>Intentional self-poisoning by and exposure to...</i>	
27	...drugs	X60-X63
28	...other and unspecified drugs, medicaments and	X64
29	biological substances	
30	...alcohol	X65
31	...organic solvents and halogenated hydrocarbons and	X66
32	their vapours	
33	...other gases and vapours	X67
34	...pesticides	X68
35	...other and unspecified chemicals and noxious	X69
36	substances	
37	<i>Intentional self-harm by...</i>	
38	...hanging, strangulation and suffocation	X70
39	...drowning and submersion	X71
40	...firearm discharge	X72-X74
41	...explosive material	X75
42	...smoke, fire and flames, or steam, hot vapours and hot	X76-X77
43	objects	
44	...sharp/blunt objects	X78-X79
45	...jumping from a high place	X80
46	...jumping or lying before a moving object, or crashing a	X81-82
47	motor vehicle	
48	...other specified means	X83
49	...unspecified means	X84
50	<i>Personal history of self-harm</i>	Z91.5

~~Alcohol~~Drug or alcohol misuse

51		
52	— Alcohol	
53	—Alcohol-induced pseudo-Cushing's syndrome	E24.4
54	—Mental and behavioural disorders due to use of alcohol	F10
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6	— Degeneration of nervous system due to alcohol	G31.2
7	— Alcoholic polyneuropathy	G62.1
8	— Alcoholic myopathy	G72.1
9	— Alcoholic cardiomyopathy	I42.1
10	— Alcoholic gastritis	K29.2
11	— Alcoholic liver disease	K70
12	— Alcohol-induced acute pancreatitis	K85.2
13	— Alcohol-induced chronic pancreatitis	K86.0
14	— Maternal care for (suspected) damage to fetus from	
15	alcohol	O35.4
16	— Fetus and newborn affected by maternal use of alcohol[†]	P04.3
17	— Fetal alcohol syndrome (dysmorphic)[†]	Q86.0
18	— Finding of alcohol in blood	R78.0
19	— Poisoning: antidotes and chelating agents, not elsewhere	
20	classified	T50.6
21	— Toxic effect of alcohol	T51
22	— Accidental poisoning by exposure to alcohol	X45
23	— Intentional self poisoning by and exposure to alcohol**	X65
24	— Poisoning by exposure to alcohol, undetermined intent	Y15
25	— Evidence of alcohol involvement determined by blood	
26	alcohol level	Y90
27	— Evidence of alcohol involvement determined by level of	
28	intoxication[‡]	Y91
29	— Alcohol rehabilitation	Z50.2
30	— Alcohol abuse counselling and surveillance	Z71.4
31	— Alcohol use[‡]	Z72.1
32	<i>Drugs, medicaments and biological substances (illicit drugs)</i>	
33	Mental and behavioural disorders due to psychoactive	
34	substance use	F11 - F17, F19
35	— Maternal care for (suspected) damage to fetus by drugs[‡]	O35.5
36	— Neonatal jaundice due to drugs or toxins transmitted from	
37	mother or given to newborn[†]	P58.4
38	— Neonatal withdrawal symptoms from maternal use of	
39	drugs of addiction[‡]	P96.1
40	Finding of drugs not normally found in blood	R78.1 - R78.5
41	Poisoning by drugs, medicaments and biological	T36 - T50
42	substances	(not including T50.6)
43	— Intentional self poisoning by and exposure to antiepileptic,	
44	sedative hypnotic, antiparkinsonism and psychotropic drugs,	X61
45	not elsewhere classified**	
46	— Intentional self poisoning by and exposure to other drugs	
47	acting on the autonomic nervous system**	X63
48	— Intentional self poisoning by and exposure to other and	
49	unspecified drugs, medicaments and biological substances**	X64
50	— Assault by drugs, medicaments and biological substances[§]	X85
51	Poisoning, undetermined intent	Y10 - Y14
52	Drug rehabilitation	Z50.3
53	Drug abuse counselling and surveillance	Z71.5
54	Drug use	Z72.2
55	<i>Environmental/ Domestic substances</i>	
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6	Mental and behavioural disorders due to use of volatile	F18
7	solvents	
8	Accidental poisoning by and exposure to noxious	X40 – X44, X46 - X49
9	substances	
10	Intentional self-poisoning by and exposure to organic	X66
11	solvents and halogenated hydrocarbons and their vapours[‡]	
12	Intentional self-poisoning by and exposure to noxious	X69
13	substances	
14	Assault by unspecified chemical or noxious substance[§]	X90
15	Poisoning by chemical or noxious substance,	Y16 - Y19
16	undetermined intent	
17	<i>Codes mentioning both alcohol and drugs</i>	
18	Special epileptic syndromes - (related to alcohol, drugs,	G40.5
19	etc.)	
20	Blood-alcohol and blood-drug test	Z04.0
21	Personal history of psychoactive substance abuse-	Z86.4
22	(alcohol, drug, tobacco)^{***}	
23		
24	<u>Alcohol</u>	
25	<u>Alcohol-induced pseudo-Cushing's syndrome</u>	<u>E24.4</u>
26	<u>Mental and behavioural disorders due to use of alcohol</u>	<u>F10</u>
27	<u>Degeneration of nervous system due to alcohol</u>	<u>G31.2</u>
28	<u>Alcoholic polyneuropathy</u>	<u>G62.1</u>
29	<u>Alcoholic myopathy</u>	<u>G72.1</u>
30	<u>Alcoholic cardiomyopathy</u>	<u>I42.1</u>
31	<u>Alcoholic gastritis</u>	<u>K29.2</u>
32	<u>Alcoholic liver disease</u>	<u>K70</u>
33	<u>Alcohol-induced acute pancreatitis</u>	<u>K85.2</u>
34	<u>Alcohol-induced chronic pancreatitis</u>	<u>K86.0</u>
35	<u>Maternal care for (suspected) damage to fetus from</u>	<u>O35.4</u>
36	<u>alcohol</u>	
37		
38		
39	<u>Finding of alcohol in blood</u>	<u>R78.0</u>
40	<u>Poisoning: antidotes and chelating agents, not elsewhere</u>	<u>T50.6</u>
41	<u>classified</u>	
42	<u>Toxic effect of alcohol</u>	<u>T51</u>
43	<u>Accidental poisoning by exposure to alcohol</u>	<u>X45</u>
44		
45	<u>Poisoning by exposure to alcohol, undetermined intent</u>	<u>Y15</u>
46	<u>Evidence of alcohol involvement determined by blood</u>	<u>Y90</u>
47	<u>alcohol level</u>	
48	<u>Evidence of alcohol involvement determined by level of</u>	<u>Y91</u>
49	<u>intoxication</u>	
50	<u>Alcohol rehabilitation</u>	<u>Z50.2</u>
51	<u>Alcohol abuse counselling and surveillance</u>	<u>Z71.4</u>
52	<u>Alcohol use</u>	<u>Z72.1</u>
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54	Accidents	
55	Transport accidents	V01 - V99
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Falls	W00 - W19
Exposure to inanimate mechanical forces	W20 - W49
Exposure to animate mechanical forces	W50 - W64
Accidental drowning and submersion	W65 - W74
Other accidental threats to breathing	W75 - W84
Exposure to electric current, radiation and extreme ambient air temperature and pressure	W85 - W99
Exposure to smoke, fire and flames	X00 - X09
Contact with heat and hot substances	X10 - X19
Contact with venomous animals and plants	X20 - X29
Exposure to forces of nature	X30 - X39
Accidental poisoning by and exposure to noxious substances	X40 - X49
Overexertion, travel and privation	X50 - X57
Accidental exposure to other and unspecified factors	X58 - X59

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6 * ~~'Strikethrough' (Phrase, code) indicates that this was not included in the~~
7 ~~adversity definition.~~

8 † ~~Codes relating to foetuses or neonates (P04.3, Q86.0, P58.4 and P96) were~~
9 ~~not expected in adolescent presentations; this was checked and did not~~
10 ~~appear.~~

11 ~~** Formed part of the self harm cluster only; self poisoning considered most~~
12 ~~egregious element of diagnosis.~~

13 ‡ ~~If subject under 18 years old.~~

14 § ~~Formed part of the victimisation cluster only; assault considered most~~
15 ~~egregious element of the diagnosis.~~

16 ~~***Not possible to distinguish whether for drugs, alcohol or tobacco~~
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Supplementary Table 3. Population prevalence* (per 100,000) of emergency admission(s) for injury, by types of adversity within age periods†^{**} and sex

Adolescent group ^{††}	All girls	All boys	Girls			Boys		
	10-19y	10-19y	10-14y	15-17y	18-19y	10-14y	15-17y	18-19y
All	9,073 ⁸⁻⁶⁶	16,333 ^{±16-27} ‡	4,104 ³⁻⁹²	3,260 ^{§3-12} §	2,189 ^{§2-11} §	7,316 ^{±7-67} ‡	5,069 ^{±5-29} ‡§	3,852 ^{±0-40} ‡§
Adversity	4,582^{±4-37}	4,108^{±4-26}‡	1,240^{±1-31}	2,124^{§2-04}§	1,329^{§1-27}§	669^{±0-72}‡	1,458^{±1-53}‡§	1,748^{±1-74}‡§
Any <u>Victimisation</u> <u>violence</u>	391 ⁰⁻⁷⁶	1,970 ^{±2-20} ‡	103 ⁰⁻²⁵	152 ^{§0-31} §	110 ⁰⁻¹⁹	277 ^{±0-33} ‡	731 ^{±0-80} ‡§	833 ^{±0-90} ‡§
Any <u>Self-harm</u>	3,418 ³⁻²⁶	1,266 ^{±1-33} ‡	777 ⁰⁻⁹⁰	1,463 ^{§1-58} §	923 ^{§0-97} §	170 ^{±0-22} ‡	393 ^{±0-47} ‡§	478 ^{±0-55} ‡§
Any <u>Drug or Alcohol</u> <u>Misuse</u>	4,194 ³⁻⁹⁸	2,463 ^{±2-47} ‡	1,112 ^{±1-16}	1,959 ^{§1-87} §	1,221 ^{§1-15} §	375 ^{±0-39} ‡	807 ^{±0-84} ‡§	1,077 ^{±1-01} ‡§
Single adversity	1,254^{±1-15}	2616^{±2-72}‡	495⁰⁻⁴⁴	687^{§0-49}§	412^{§0-32}§	516⁰⁻⁵³‡	991^{±0-99}‡§	1,114^{±1-08}‡§
<u>Victimisation-Violence</u> <u>Only</u>	235 ⁰⁻²⁴	1,496 ^{±1-63} ‡	77 ⁰⁻⁰⁹	99 ^{§0-10} §	75 ⁰⁻⁰⁸	256 ^{±0-28} ‡	609 ^{±0-64} ‡§	635 ^{±0-69} ‡§
<u>Self-harm</u> <u>Only</u>	144 ⁰⁻¹³	136 ⁰⁻¹⁴	48 ⁰⁻⁰⁵	63 ^{§0-06} §	31 ^{§0-03} §	37 ^{±0-05} ‡	39 ⁰⁻⁰⁴ ‡§	34 ⁰⁻⁰⁴ ‡
<u>Drug or Alcohol</u> <u>Misuse</u> <u>Only</u>	874 ⁰⁻⁷⁸	984 ^{±0-95} ‡	369 ⁰⁻²⁹	525 ^{§0-33} §	305 ^{§0-21} §	224 ^{±0-21} ‡	342 ^{±0-31} ‡§	445 ^{±0-35} ‡§
Multiple adversity	3,328^{±3-22}	1,492^{±1-54}‡	745⁰⁻⁸⁸	1,436^{§1-55}§	917^{§0-95}§	153^{±0-19}‡	467^{±0-54}‡§	634^{±0-66}‡§
V+SH	8 ⁰⁻⁰²	13 ^{±0-02} ‡	3 ⁰⁻⁰¹	3 ⁰⁻⁰¹	1 ^{§0-004} §	1 ^{±0-005} ‡	2 ⁰⁻⁰¹ ‡§	2 ⁰⁻⁰¹ ‡
V+DA	54 ⁰⁻⁰⁸	361 ^{±0-35} ‡	17 ⁰⁻⁰³	37 ^{§0-03} §	26 ^{§0-02} §	19 ⁰⁻⁰² ‡	114 ^{±0-11} ‡§	190 ^{±0-15} ‡§
SH+DA	3,172 ²⁻⁷⁰	1,018 ^{±0-97} ‡	72 ⁰⁰⁻⁷²	1,384 ^{§1-34} §	882 ^{§0-84} §	131 ^{±0-14} ‡	345 ^{±0-37} ‡§	436 ^{±0-45} ‡§
V+SH+DA	93 ⁰⁻⁴²	100 ^{±0-20} ‡	6 ⁰⁻¹²	13 ^{§0-17} §	8 ⁰⁻⁰⁹	2 ^{±0-02} ‡	5 ^{±0-05} ‡§	6 ^{§0-06} ‡§
No adversity	4,491 ⁴⁻²⁹	11,417 ^{±12-04} ‡	2,676 ²⁻⁷⁹	1,136 ^{§1-08} §	860 ^{§0-84} §	6,648 ^{±6-95} ‡	3,611 ^{±3-76} ‡§	2,171 ^{±2-26} ‡§
Accidents <u>Only</u>	748⁰⁻⁷⁴	10,466^{±1-00}‡	2,221⁰⁻³²	804^{§0-26}§	580^{§0-24}§	5,887^{±0-47}‡	3,109^{±0-36}‡§	1,784^{±0-31}‡§
Other <u>Causes</u>	3,742³⁻⁵⁸	951^{±11-04}‡	455²⁻⁴⁷	332^{§0-82}§	279^{§0-60}§	761^{±6-48}‡	503^{±3-40}‡§	388^{±1-95}‡§

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9 | V = ~~Victimisation~~Violence, SH = Self-harm, DA = Drug or Alcohol Misuse, ~~AdvRI = Adversity related Injury, AccRI Only = Accident~~
10 | ~~related Injury Only~~

11 *Due to large denominators, confidence intervals for population prevalence were too narrow to provide any meaningful
12 interpretation and so are not shown.

13 | †** Each adolescent classified by all adversity/accidents seen at any emergency injury admission(s) at 10-19 years, 10-14 years,
14 15-17 years and 18-19 years, respectively.

15 ‡Statistically significantly different from girls of the same age (according to 95% confidence intervals).

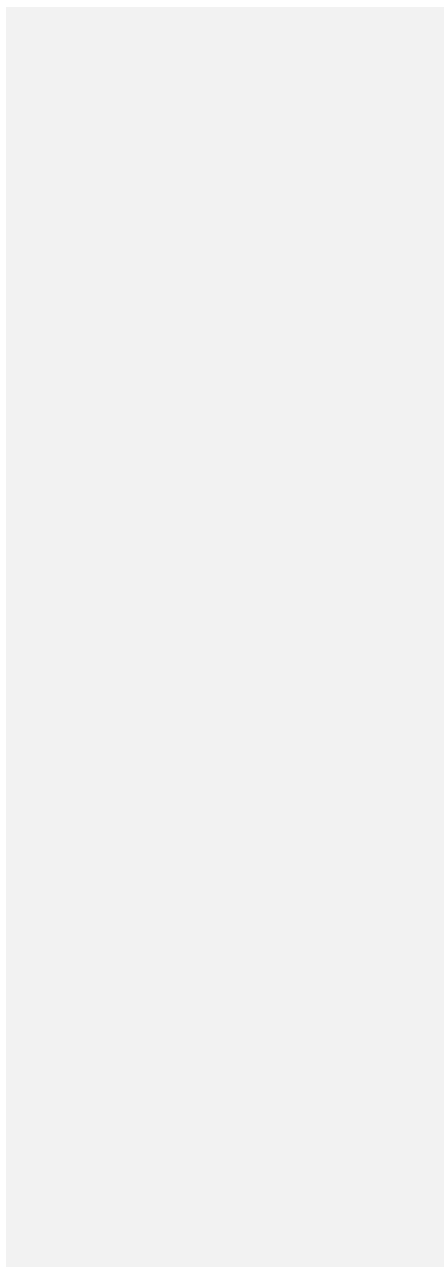
16 §Statistically significantly different from 10-14 year olds of the same sex (according to 95% confidence intervals).
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STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract (b) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported
Objectives	3	State specific objectives, including any prespecified hypotheses
Methods		
Study design	4	Present key elements of study design early in the paper
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants	6	(a) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up <i>Case-control study</i> —Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants (b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed. N/A <i>Case-control study</i> —For matched studies, give matching criteria and the number of controls per case
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
Bias	9	Describe any efforts to address potential sources of bias. We only analysed those who could be observed between ages 10 and 19, so no bias due to different lengths of admission trajectories.
Study size	10	Explain how the study size was arrived at. All available administrative data.
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding (b) Describe any methods used to examine subgroups and interactions (c) Explain how missing data were addressed. N/A (d) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed. We only analysed those who could be observed between ages 10 and 19. <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed <i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy (e) Describe any sensitivity analyses. N/A

Continued on next page

Results

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed (b) Give reasons for non-participation at each stage. <i>N/A</i> (c) Consider use of a flow diagram. <i>We didn't use a flow diagram as eligibility could be described using one sentence.</i>
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (b) Indicate number of participants with missing data for each variable of interest (c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount). <i>N/A</i>
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time. <i>We state how many emergency admissions for adversity-related injury the adversity group had. We also provide a table indicating the number of emergency admissions for injury and admissions (of any type) during ages 10-19.</i> <i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure <i>Cross-sectional study</i> —Report numbers of outcome events or summary measures
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included. <i>We gave prevalence estimates stratified by age-group and sex.</i> (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period. <i>N/A</i>
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses

Discussion

Key results	18	Summarise key results with reference to study objectives
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability	21	Discuss the generalisability (external validity) of the study results

Other information

Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based
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*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Violence, self-harm and drug or alcohol misuse in adolescents admitted to hospitals in England for injury: a retrospective cohort study

Journal:	<i>BMJ Open</i>
Manuscript ID:	bmjopen-2014-006079.R2
Article Type:	Research
Date Submitted by the Author:	22-Jan-2015
Complete List of Authors:	Herbert, Anne; UCL Institute of Child Health, Population, Policy and Practice Programme Gilbert, Ruth; UCL Institute of Child Health, Population, Policy and Practice Programme Gonzalez-Izquierdo, Arturo; UCL Institute of Child Health, Population, Policy and Practice Programme Li, Leah; UCL Institute of Child Health, Population, Policy and Practice Programme
Primary Subject Heading:	Paediatrics
Secondary Subject Heading:	Mental health, Health services research
Keywords:	MENTAL HEALTH, Non-accidental injury < PAEDIATRICS, Substance misuse < PSYCHIATRY, Suicide & self-harm < PSYCHIATRY

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Manuscripts

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5 **1 Violence, self-harm and drug or alcohol misuse in**
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7 **2 adolescents admitted to hospitals in England for injury: a**
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9 **3 retrospective cohort study**
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36
37 Short title: Adversity in adolescents admitted to hospital for injury
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39 *Key words: Wounds and Injuries, Violence, Self-injurious Behaviour,*
40 *Substance-related Disorders, Adolescent*
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44
45
46 Word count: 2,604
47

48 No. figures: 2
49

50 No tables: 2
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52 No references: 35
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54 No supplementary files for online only publication: 5
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4 24 **ABSTRACT**

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6 25 **Objectives**

7
8 26 Of adolescents in the general population in England, we aimed to determine
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10 27 1) the proportion that has an emergency admission to hospital for injury
11
12 28 related to adversity (violence, self-harm or drug or alcohol misuse) and 2) the
13
14 29 risk of recurrent emergency admissions for injury in adolescents admitted with
15
16 30 adversity-related injury compared with those admitted with accident-related
17
18 31 injury only.

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21 32 **Design**

22
23 33 We used longitudinally-linked administrative hospital data (Hospital Episode
24
25 34 Statistics) to identify 10-19 year olds with emergency admissions for injury
26
27 35 (including day cases lasting more than four hours), in England in 1998-2011.
28
29 36 We used Office for National Statistics mid-year estimates for population
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31 37 denominators.

32
33 38 **Results**

34
35 39 Approximately 4.3% (n=141 248) of adolescents in the general population
36
37 40 (n=3 254 046) had one or more emergency admissions for adversity-related
38
39 41 injury (girls 4.6%, boys 4.1%), accounting for 50.0% of all emergency
40
41 42 admissions for injury in girls and 29.1% in boys. Admissions for self-harm or
42
43 43 drug or alcohol misuse commonly occurred in the same girls and boys.
44
45 44 Recurrent emergency admissions for injury were more common in
46
47 45 adolescents with adversity-related injury (girls 17.3%; boys 16.5%) than in
48
49 46 those with accident-related injury only (girls 4.7%; boys 7.4%), particularly for
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51 47 adolescents with adversity-related injury related to multiple types of adversity
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53 48 (girls 21.1%; boys 24.2%).
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49 **Conclusion**

50 Hospital-based interventions should be developed to reduce the risk of future
51 injury in adolescents admitted for adversity-related injury.

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3 52 **What is already known on this subject**
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- 5 53 • Adolescents exposed to adversity (violence, self-harm or drug or
6 alcohol misuse) often use health services, and repetitively.
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8
9 55 • Many adolescents in the general population are exposed to multiple
10 types of adversity during their adolescence.
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17 58 **What this study adds**

- 18
19 59 • One in 20 adolescents in England has an emergency admission to
20 hospital for adversity-related injury between 10 and 19 years old.
21 60
22
23 61 • Many adolescents admitted with adversity-related injury (particularly
24 girls) are admitted with multiple types of adversity, self-harm and drug
25 or alcohol misuse being the most common combination.
26 62
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30 64 • Re-admission is more common in these adolescents than those
31 admitted with accident-related injury only.
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37 67 **Strengths and limitations of this study**

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39 68 • Hospital Episodes Statistics (HES) captured data on all admissions to
40 National Health Service hospitals in England at 10-19 years old in this
41 study's cohort.
42 69
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44 70
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46 71 • The longitudinal link between admissions for each individual in HES
47 data allowed us to study the burden of multiple emergency admissions
48 for injury over time.
49 72
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51 73
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53 74 • However, violence, self-harm and drug or alcohol misuse are not
54 always recognised at an admission, or consistently recorded, and
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76 therefore this study’s estimates of prevalence of adversity are likely to
77 be underestimates.

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3 **78 INTRODUCTION**
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5 79 Many adolescents exposed to adversity such as violence, self-harm, or drug
6
7 80 or alcohol misuse use secondary health services,[1 2] often repetitively.[3 4]
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9 81 For example, in a self-report survey of 15-16 year olds in England, 12.6% of
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11 82 those who had self-harmed had presented to hospital.[2] It is also estimated
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13 83 that approximately one-third of patients attending a hospital in England for
14
15 84 self-harm re-attend for self-harm in the following year.[4] Improved
16
17 85 management of adolescents exposed to adversity could reduce risk of
18
19 86 repetition as well as the burden on secondary care.[5-7]
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23 87 An admission to hospital provides the 'teachable moment'. [8] That is,
24
25 88 both adolescents and their families may be more likely to engage with an
26
27 89 intervention than if they had received it elsewhere. Hospital-based
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29 90 interventions to reduce the risk of future harm could benefit these adolescents
30
31 91 by reducing episodes of injury, and may reduce recurrent emergency (i.e.,
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33 92 acute or unplanned) admissions for injury.
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36 93 To date, there is a lack of evidence on how different types of adversity-
37
38 94 related injury occur in the same adolescents over time. In addition, policy
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40 95 makers and service providers need to know how many adolescents have an
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42 96 emergency admission to hospital for adversity-related injury, their
43
44 97 characteristics and their specific rates of re-admission if they are to be
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46 98 feasibly targeted for intervention.
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49 99 In this study we used administrative hospital data and Office for
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51 100 National Statistics (ONS) mid-year population estimates to estimate the
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53 101 number of adolescents in the general population who have ever had an
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55 102 emergency admission to hospital for injury. We then estimated the
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3 103 prevalence of emergency admissions for injury related to violence, self-harm
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5 104 and drug or alcohol misuse (alone and co-occurring) in the general
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7 105 population. Finally, we determined the risk of recurrent emergency
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10 106 admissions for injury in adolescents who had at least one admission between
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12 107 10 and 19 years for adversity-related injury compared with adolescents only
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14 108 ever admitted for accidental injury during the same period.
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5 109 **METHODS**
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8 110 **Study population**
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10 111 Using administrative data from all admissions to National Health Service
11 hospitals in England (Hospital Episode Statistics [HES]) in 1998-2011,[9] we
12 derived a retrospective cohort of adolescents who turned 10 years old in
13 1998-2002, who could be observed throughout adolescence until 19 years old
14 (Supplementary Table 1).[10] Each individual also had to have at least one
15 emergency admission for injury between 10 and 19 years old.
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24 117 **Admission data**
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26 118 The Health and Social Care Information Centre provided pseudonymised data
27 on hospital admissions, use of which did not require Research Ethics
28 Committee approval.[11] An admission is defined by the National Health
29 Service as any hospital case lasting longer than four hours, and so includes
30 long day cases as well as overnight stays. We analysed any hospital
31 transfers or admissions within one day after discharge as the same
32 admission, as previously described.[12] We used the variable for method of
33 admission ('admimeth') to define an emergency admission. We used all
34 International Classification of Diseases-10 (ICD-10) diagnosis codes recorded
35 during an admission to categorise admissions as being for injury related to
36 adversity or an accident (Supplementary Table 2).[13]
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51 129 **Types of injury and age at emergency admission**
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53 130 We defined an emergency admission for injury as being related to adversity,
54 comprising violence (maltreatment/assault/undetermined causes of injury),
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3 132 self-harm or drug or alcohol misuse, using mutually exclusive clusters of ICD-
4
5 133 10 codes (Supplementary Table 2). Violence was defined by previously-
6
7 134 validated codes, which would trigger consideration of violence by carers,
8
9 135 peers or strangers.[12 14 15] We defined self-harm using codes that
10
11 136 mentioned either 'self-harm' or 'self-poisoning'. Drug or alcohol misuse was
12
13 137 defined by codes that mentioned 'alcohol', 'drugs', 'noxious substance' or
14
15 138 'solvent'. We defined an injury as being related to accidents only if no
16
17 139 adversity codes were present but there were codes from the ICD-10
18
19 140 *Accidents* subchapter (V01-X59).[13]

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23 141 We grouped age at each admission to reflect age of onset of puberty
24
25 142 (10-14 years), age of sitting secondary school exams (15-17 years) and the
26
27 143 legal age for buying alcohol (18-19 years).[16-19]

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30 144 **Classification of adolescents according to types of injury and age at**
31
32 145 **emergency admissions**

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34
35 146 We classed adolescents into groups according to all of their emergency
36
37 147 admissions for injury between 10 and 19 years old. Adolescents were
38
39 148 classed as belonging to the 'adversity' group (any adversity-related injury
40
41 149 between 10 and 19 years old), 'accidents only' group (no adversity-related
42
43 150 injury but one or more accident-related injuries) or 'other causes' group (no
44
45 151 adversity-related or accident-related injuries) (Supplementary Figure 1).
46
47 152 Among adolescents in the adversity group, we determined the proportion
48
49 153 exposed to violence-, self-harm- and drug or alcohol misuse-related injury at
50
51 154 age 10-19, respectively. We further classified the adversity group into seven
52
53 155 mutually exclusive sub-groups: violence only, self-harm only, drug or alcohol
54
55 156 misuse only, violence and self-harm, violence and drug or alcohol misuse,
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3 157 self-harm and drug or alcohol misuse, and violence, self-harm and drug or
4
5 158 alcohol misuse.

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7 159 We also grouped adolescents as above, according to their emergency
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9
10 160 admissions for injury at 10-14 years only, 15-17 years only and 18-19 years
11
12 161 only (Supplementary Figure 2).

162 **Population denominators**

163 We used ONS mid-year population estimates to derive population
164 denominators.[20 21] These data are freely available online broken down by
165 sex and year of age.

166 **Analyses**

167 We estimated the proportion of adolescents in the general population who had
168 an emergency admission for injury between 10 and 19 years old. We used
169 the number of adolescents in our derived retrospective cohort as the
170 numerator and ONS mid-year estimates for 10 year olds in 1998-2002 as the
171 population denominator. We then calculated these proportions by types of
172 injury at 10-19 years old (adversity-related [adversity group and seven
173 mutually exclusive subgroups] and accidents only [accidents only group]) and
174 by age group, as described above.

175 We calculated the proportion of adolescents in the adversity group (and
176 subgroups) and in the accidents only group who had an emergency admission
177 for injury twice and three or more times between 10 and 19 years old. We
178 also calculated the proportions of adolescents with two or three or more
179 admissions of any type (including non-emergency and non-injury).

180 We reported all results separately for girls and boys since differences
181 between girls and boys have been reported for prevalence of adversity in the

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3 182 general population.[1 22-24] We calculated 95% confidence intervals for all
4
5 183 proportions but did not present them here as they were all too narrow to
6
7 184 convey any useful information (within one unit of the sample estimate).
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10 185 Analyses were carried out in StataSE 12.
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5 186 **RESULTS**
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7 187 There were 1 033 702 adolescents in HES admissions data in 1998-2011, of
8
9 188 which 402 916 formed the study cohort (462 476 emergency admission for
10
11 189 injury when considering multiple presentations from the same adolescent, 802
12
13 190 682 admissions of any type [including non-emergency and non-injury, 662
14
15 191 727 of which were overnight stays]) (Table 1), representing 12.4% (402 916/3
16
17 192 254 046) of the adolescent population. Twice as many boys as girls had an
18
19 193 emergency admission for injury during adolescence (144 158/1 588 942 girls
20
21 194 in the population [8.7%]; 258 503/1 665 104 boys [16.3%]).
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195 **Table 1.** Characteristics of adolescents whose entire ten years of adolescence (ages 10-19) occurred in 1998-2011.

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Characteristics	Adolescent population*	Adolescents with emergency admission(s) for injury between 10 and 19 years old, n (row %)			
	Total	Total	Adversity	Accidents only	Other causes
All	3,254,046	402,916 (100.0)	141,248 (35.1)	233,907 (58.1)	27,761 (6.9)
Age**					
Girls	1,588,942	144,158 (100.0)	72,805 (50.5)	59,528 (41.3)	11,888 (8.2)
10-14 years	.	65,208 (100.0)	23,178 (35.5)	37,388 (57.3)	4,642 (7.1)
15-17 years	.	48,286 (100.0)	31,573 (65.4)	12,922 (26.8)	3,791 (7.9)
18-19 years	.	30,664 (100.0)	18,054 (58.9)	9,155 (29.9)	3,455 (11.3)
Boys	1,665,104	258,503 (100.0)	68,403 (26.5)	174,267 (67.4)	15,833 (6.1)
10-14 years	.	121,821 (100.0)	17,667 (14.5)	97,478 (80.0)	6,676 (5.5)
15-17 years	.	79,223 (100.0)	25,014 (31.6)	49,345 (62.3)	4,864 (6.1)
18-19 years	.	57,459 (100.0)	25,722 (44.8)	27,444 (47.8)	4,293 (7.5)
Missing (Sex)	.	255 (100.0)	40 (15.7)	175 (68.6)	40 (15.7)

197 *Based on ONS mid-year England statistics for 10 year olds in 1998-2002.[20]

198 **At first emergency admission for injury

199 **Types of injury and age at emergency admission**

200 One-third of the cohort (141 248, 4.3% of the population) had a record of an
201 emergency admission for adversity-related injury between 10 and 19 years
202 old (the adversity group; 157 004 emergency admissions for adversity-related
203 injury in total) (Table 1), with similar rates between sexes (72 805, 4.6% girls
204 in the population; 68 403, 4.1% boys).

205 The remaining two-thirds of the cohort (261 668, 8.1% of the
206 adolescent population) had emergency admissions for injury which were
207 never related to adversity (Table 1). Among these adolescents, 233 907
208 (89.4%) had an accident-related injury (the accidents only group, 7.2% of the
209 population) and 27 761 (10.6%) had no accident-related injury (other causes
210 group, 0.9% of the population). A high proportion of the other causes group
211 were affected by a chronic condition¹ between 10 and 19 years old (11 221/27
212 761, 40.4%), compared with the adversity group (45 321/141 248, 32.1%) or
213 accidents only group (49 434/233 907, 21.1%).

214 Proportions of adolescents in the general population and within
215 individual age groups by adversity [and subgroups], accidents only, and other
216 causes groups are provided in Supplementary Table 3.

217 **Types of adversity-related injury**

218 Among adolescents in the adversity group (girls 72 805, boys 68 403) (Figure
219 1), the most common type of adversity was drug or alcohol misuse (girls
220 91.5%, boys 60.0%). A higher proportion of boys than girls were exposed to

¹ Defined by ICD-10 codes (Supplementary Table 2)

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3 221 violence (girls 8.5%, boys 47.6%), but a higher proportion of girls than boys
4
5 222 were exposed to self-harm (girls 74.6%; boys 32.9%).
6

7 223 Girls in the adversity group were most likely to be exposed to multiple
8
9 224 types of adversity between 10 and 19 years old (69.2% + 2.0% + 1.2% + 0.2%
10
11 225 = 72.6%) (Figure 1), especially self-harm and drug or alcohol misuse (69.2%
12
13 226 of the entire adversity group, i.e., most of the 72.6%). Fewer boys in the
14
15 227 adversity group were exposed to multiple types of adversity (38.4%), the most
16
17 228 common combination also being self-harm and drug or alcohol misuse
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19 229 (24.8%).
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23 230 For most of the adolescents who were exposed to multiple types of
24
25 231 adversity, the combination of types was recorded at the same admission. For
26
27 232 example, among the 130 adolescent girls who were exposed to violence and
28
29 233 self-harm between 10 and 19 years old (Table 2), 64.6% had both violence
30
31 234 and self-harm codes present simultaneously in at least one emergency
32
33 235 admission for injury (violence and drug or alcohol misuse 78.8%, self-harm
34
35 236 and drug or alcohol misuse 99.7%, violence, self-harm and drug or alcohol
36
37 237 misuse 33.9%; boys: violence and self-harm 40.1%, violence and drug or
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39 238 alcohol misuse 84.1%, self-harm and drug or alcohol misuse 99.1%, violence,
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41 239 self-harm and drug or alcohol misuse 20.0%) (data not shown).
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240 **Table 2.** Proportion of adolescents with 1, 2 or 3+ emergency admission(s) for injury or 1, 2 or 3+ admission(s) of any type, by
 241 types of adversity between 10 and 19 years old*

Adolescent group*	No. girls	Girls (%)						No. boys	Boys (%)					
		Emergency admission(s) for injury			Admission(s) of any type				Emergency admission(s) for injury			Admission(s) of any type		
		1	2	3+	1	2	3+		1	2	3+	1	2	3+
All	144,158	88.6	8.3	3.1	57.6	20.5	22.0	258,503	90.3	8.0	1.8	68.5	18.7	12.9
Adversity	72,805	82.7	12.0	5.3	53.8	21.1	25.1	68,403	83.5	12.4	4.1	64.8	19.4	15.8
Any violence	6,211	77.2	13.9	8.9	49.1	20.7	30.1	32,799	83.2	12.8	4.0	65.6	19.6	14.8
Any self-harm	54,315	79.3	13.9	6.8	51.2	21.5	27.3	21,087	76.7	15.8	7.5	57.0	20.7	22.3
Any drug or alcohol misuse	66,645	81.9	12.5	5.6	53.6	21.1	25.3	41,014	81.1	13.6	5.3	62.9	19.5	17.6
Single adversity	19,924	92.8	6.2	1.0	61.2	19.8	19.0	43,563	71.3	8.3	1.8	55.8	15.2	10.3
Violence only	3,734	92.4	6.3	1.3	58.1	20.4	21.6	24,912	87.1	10.6	2.2	68.3	19.2	12.6
Self-harm only	2,296	90.3	8.1	1.6	54.4	20.7	24.9	2,260	87.3	10.4	2.3	62.3	19.8	17.9
Drug or alcohol misuse only	13,894	93.3	5.9	0.8	63.2	19.5	17.4	16,391	88.5	9.5	2.1	69.9	17.9	12.2
Multiple adversity	52,881	78.9	14.2	6.9	51.0	21.6	27.4	24,840	77.3	16.7	7.5	59.0	21.0	21.5
V + SH	130	70.0	20.8	9.2	42.3	26.2	31.5	217	41.6	15.4	6.1	32.8	16.0	14.2

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V + DA	862	81.9	15.1	3.0	52.2	22.9	24.9	6,013	84.6	17.5	5.4	68.4	21.8	17.3
SH + DA	50,404	80.1	13.7	6.3	51.8	21.6	26.6	16,953	86.7	16.4	6.9	64.6	22.7	22.9
V + SH + DA	1,485	36.8	31.6	31.5	25.5	19.9	54.5	1,657	22.0	16.4	14.1	17.9	11.7	22.8
No adversity	71,353	94.7	4.5	0.8	61.4	19.9	18.7	190,100	92.4	6.3	0.9	69.5	18.3	11.8
Accidents only	59,465	95.3	4.1	0.6	66.5	18.7	14.7	174,267	92.3	6.5	0.9	71.1	18.0	10.5
Other causes	11,888	91.5	6.3	2.1	35.5	25.8	38.8	15,833	93.4	5.0	1.6	51.5	22.1	26.3

242 V = Violence, SH = Self-harm, DA = Drug or Alcohol Misuse
 243 * Each adolescent classified by all adversity/accidents seen at any emergency admission(s) for injury between 10 and 19 years old.

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4 244 **Emergency re-admissions for injury**

5
6 245 Adolescent girls in the adversity group (50.5% of all girls in the cohort)
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8 246 accounted for 50.0% of the total number of emergency admissions for injury
9
10 247 coming from girls (data not shown), compared with girls in the accidents only
11
12 248 group (41.3% of all girls) who accounted for 36.6%. Boys in the adversity
13
14 249 group (26.2% of all boys in the cohort) accounted for 29.1% compared with
15
16 250 65.0% contributed by boys in the accidents only group (67.7% of all boys).

17
18 251 More adolescents in the adversity group were re-admitted for injury
19
20 252 (i.e., had two or more emergency admissions for injury) between 10 and 19
21
22 253 years old (girls 17.3%, boys 16.5%) (Figure 2), than in the accidents only
23
24 254 group (girls 4.7%; boys 7.4%). Among adolescents admitted for injuries
25
26 255 related to multiple types of adversity (Table 2), the proportion re-admitted was
27
28 256 even higher (multiple types: girls 21.1%, boys 24.2%; single type: girls 7.2%,
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30 257 boys 10.1%).

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34 258 Similarly, a higher proportion of adolescents in the adversity group had
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36 259 two more admissions of any type (including non-emergency and non-injury)
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38 260 between 10 and 19 years old (girls 46.2%; boys 35.2%) (Table 2) compared
39
40 261 with adolescents in the accidents only group (girls 33.4%; boys 28.5%). This
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42 262 proportion was even higher for adolescents in the adversity group who were
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44 263 admitted with multiple types of adversity (multiple types: girls 49.0%, boys
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46 264 42.5%; single type: girls 38.8%, boys 25.5%).
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3 265 **DISCUSSION**
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5 266 More than one in 20 adolescents in England had at least one emergency
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7 267 admission for adversity-related injury between 10 and 19 years old. These
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9 268 adolescents accounted for a third of all adolescents with emergency
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11 269 admissions for injury and for a disproportionate number of re-admissions for
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13 270 injury, particularly adolescents admitted with multiple types of adversity-
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15 271 related injury. Targeting adolescents admitted with adversity-related injury
16
17 272 could reduce their risk of future harm, the rate of re-admissions to hospital,
18
19 273 and health care costs .[25]
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22
23 274 Longitudinally-linked admissions allowed us to study the entire ten
24
25 275 years of adolescence in 402 916 individuals. We were able to distinguish
26
27 276 between types of adversity that co-occurred during adolescence or at the
28
29 277 same admission, and to study re-admissions. One weakness of this study
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31 278 was our reliance on diagnostic codes recorded in administrative data.
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34 279 Violence by carers, which could be coded under maltreatment, and drug or
35
36 280 alcohol misuse have been shown to be under-recorded using ICD-10,[26 27]
37
38 281 but false positives are rare.[15] To address under-recording, we used what
39
40 282 we considered to be sensitive clusters of codes for adversity. Other factors
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42 283 related to recording or coding practices,[12 14 15 27 28] for example, new
43
44 284 guidelines for defining maltreatment,[14] can also affect ascertainment.
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47 285 Because of the relative insensitivity but good specificity of the coding clusters,
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49 286 some adolescents who were classified in the accidents only group may in fact
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51 287 belong to the adversity group, but did not have their adversity recognised or
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53 288 recorded. Consequently, our prevalence estimates of admission for different
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55 289 types of adversity-related injury are likely to provide a lower bound for the true
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3 290 prevalence. Further, as adolescents exposed to adversity who attended the
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5 291 accident and emergency (A&E) department were not necessarily admitted,
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7 292 our prevalence estimates represent adolescents at the severe end of the
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10 293 adversity spectrum. Such analyses of A&E data are limited by the quality of
11
12 294 these data in England (available since 2007) and the resulting problems with
13
14 295 identifying reasons for presentation and accurately linking individuals to long-
15
16 296 term outcomes.[29]

17
18 297 Our prevalence estimates of admission for injury related to individual
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20 298 types of adversity from the general adolescent population are consistent with
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22 299 previous reports for emergency admissions for assault-related injury in 2004-
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24 300 2009 and for all admissions (emergency and non-emergency) for self-harm
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26 301 and drug or alcohol misuse.[1 2 24 30] Previous studies have reported higher
27
28 302 rates of drug or alcohol misuse in boys than in girls in the general adolescent
29
30 303 population.[24] We found higher rates in girls. This difference could indicate
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32 304 that girls exposed to drug or alcohol misuse are more likely to be injured, to
33
34 305 present to hospital, or to be admitted after a hospital presentation, than boys.
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38 306 Our estimated rates of re-admission of any type (including non-
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40 307 emergency and non-injury) for violence (girls 50.8%, boys 34.4%) (Table 2)
41
42 308 and self-harm (girls 48.8%, boys 43.0%) were higher than previously reported
43
44 309 (11% for violence, 33% for self-harm).[3 4] These discrepancies are likely to
45
46 310 be because we considered the whole ten years of adolescence and re-
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48 311 admission of any type, whereas previous studies looked at re-attendance up
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50 312 to the following year and for the same type of adversity-related injury.[3 4]
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53 313 The results of this study should inform policy initiatives and national
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55 314 guidelines. Firstly, a substantial proportion of adolescents are affected by
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3 315 adversity and they account for a large proportion (29.1 to 50.0%) of all
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5 316 emergency admissions to hospital for injury in this age group. Secondly, we
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7 317 show the large burden of injury admission for all three types of adversity, yet
8
9 318 there are currently no national clinical guidelines for managing cases of
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11 319 violence, other than responding to violence by caregivers.[31] Finally, these
12
13 320 results show that adolescents often present with multiple types of adversity
14
15 321 (especially in girls), even though guidelines exist only for managing individual
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17 322 problems.[32-34]

20
21 323 In addition, policy makers need to be aware of the widely varying
22
23 324 aetiological pathways to admission with adversity-related injury. Our
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25 325 approach to defining this group of adolescents is not designed to reflect the
26
27 326 complexity or severity of these cases. For example, admission for multiple
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29 327 types of adversity-related injury is a poor proxy indicator of severity. Effective
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31 328 interventions will need to be tailored to the individual based on specialist
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33 329 clinical assessment. However, all three types of adversity are likely to reflect
34
35 330 a combination of underlying psychosocial need and environmental and social
36
37 331 stressors.[35]

40
41 332 Hospital interventions may reduce the risk of future harm, including the
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43 333 incidence of other types of harm not seen in hospital, e.g., further adversity-
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45 334 related injury not leading to admission. Further research using linked data
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47 335 from health care sectors such as accident and emergency, could shed light on
48
49 336 the overall burden of adversity-related injury on hospitals. Though these data
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51 337 have limited quality in England, longitudinally-linked datasets in other
52
53 338 countries could provide insights into long-term outcomes for this vulnerable
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55 339 group of adolescents.

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5 340 **Contributors**
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7 341 Annie Herbert – helped to conceive and design the study, analysed and
8
9 342 interpreted the data, drafted the article, revised it critically for important
10
11 343 intellectual content and approved the final version to be published.

12
13 344 Leah Li – helped to conceive and design the study, interpreted the data,
14
15 345 revised the article critically for important intellectual content and approved the
16
17 346 final version to be published.

18
19 347 Arturo González-Izquierdo – helped to conceive and design the study,
20
21 348 acquired and interpreted the data, revised the article critically for important
22
23 349 intellectual content and approved the final version to be published.

24
25 350 Ruth Gilbert – helped to conceive and design the study, acquired and
26
27 351 interpreted the data, revised the article critically for important intellectual
28
29 352 content and approved the final version to be published.

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31 353
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36 355

37
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4
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6
7 367 manuscript or the decision to submit the paper for publication, and the
8
9
10 368 authors' work was independent of their funders.

369

14 370 **Ethics** Both Hospital Episode Statistics (HES) admissions data and Office for
15
16 371 National Statistics (ONS) mid-year population estimates are derived from
17
18 372 routinely collected administrative data. HES data were pseudonymised
19
20
21 373 before we received them and therefore we did not require Research Ethics
22
23 374 Committee approval.

375

27 376 **Data sharing** No additional data on HES are available. ONS mid-year
28
29 377 population estimates may be accessed freely online:
30
31
32 378 [http://www.ons.gov.uk/ons/publications/all-](http://www.ons.gov.uk/ons/publications/all-releases.html?definition=tcm%3A77-22371)
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34 379 [releases.html?definition=tcm%3A77-22371](http://www.ons.gov.uk/ons/publications/all-releases.html?definition=tcm%3A77-22371).

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8 **1 Violence, self-harm and drug or alcohol misuse in**
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10 **2 adolescents admitted to hospitals in England for injury: a**
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12 **3 retrospective cohort study**
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39 *Substance-related Disorders, Adolescent*
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25 ABSTRACT**26 Objectives**

27 Of adolescents in the general population in England, we aimed to determine
28 1) the proportion that has an emergency admission to hospital for injury
29 related to adversity (violence, self-harm or drug or alcohol misuse) and 2) the
30 risk of recurrent emergency admissions for injury in adolescents admitted with
31 adversity-related injury compared with those admitted with accident-related
32 injury only.

33 Design

34 We used longitudinally-linked administrative hospital data (Hospital Episode
35 Statistics) to identify 10-19 year olds with emergency admissions for injury
36 (including day cases lasting more than four hours), in England in 1998-2011.
37 We used Office for National Statistics mid-year estimates for population
38 denominators.

39 Results

40 Approximately 4.3% (n=141 248) of adolescents in the general population
41 (n=3 254 046) had one or more emergency admissions for adversity-related
42 injury (girls 4.6%, boys 4.1%), accounting for 50.0% of all emergency
43 admissions for injury in girls and 29.1% in boys. Admissions for self-harm or
44 drug or alcohol misuse commonly occurred in the same girls and boys.
45 Recurrent emergency admissions for injury were more common in
46 adolescents with adversity-related injury (girls 17.3%; boys 16.5%) than in
47 those with accident-related injury only (girls 4.7%; boys 7.4%), particularly for

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6 48 adolescents with adversity-related injury related to multiple types of adversity
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8 49 (girls 21.1%; boys 24.2%).
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10 **Conclusion**

11 Hospital-based interventions should be developed to reduce the risk of future
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14 52 injury in adolescents admitted for adversity-related injury.
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6 53 **What is already known on this subject**
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- 8 54 • Adolescents exposed to adversity (violence, self-harm or drug or
9 alcohol misuse) often use health services, and repetitively.
10 55
11 56 • Many adolescents in the general population are exposed to multiple
12 types of adversity during their adolescence.
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18 59 **What this study adds**
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- 20 60 • One in 20 adolescents in England has an emergency admission to
21 hospital for adversity-related injury between 10 and 19 years old.
22 61
23 62 • Many adolescents admitted with adversity-related injury (particularly
24 girls) are admitted with multiple types of adversity, self-harm and drug
25 or alcohol misuse being the most common combination.
26 63
27 64 • Re-admission is more common in these adolescents than those
28 admitted with accident-related injury only.
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36 68 **Strengths and limitations of this study**
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- 38 69 • Hospital Episodes Statistics (HES) captured data on all admissions to
39 National Health Service hospitals in England at 10-19 years old in this
40 study's cohort.
41 70
42 71 • The longitudinal link between admissions for each individual in HES
43 data allowed us to study the burden of multiple emergency admissions
44 for injury over time.
45 72
46 73 • However, violence, self-harm and drug or alcohol misuse are not
47 always recognised at an admission, or consistently recorded, and
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6 77 therefore this study's estimates of prevalence of adversity are likely to
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8 78 be underestimates.
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79 INTRODUCTION

80 Many adolescents exposed to adversity such as violence, self-harm, or drug
81 or alcohol misuse use secondary health services,[1 2] often repetitively.[3 4]
82 For example, in a self-report survey of 15-16 year olds in England, 12.6% of
83 those who had self-harmed had presented to hospital.[2] It is also estimated
84 that approximately one-third of patients attending a hospital in England for
85 self-harm re-attend for self-harm in the following year.[4] Improved
86 management of adolescents exposed to adversity could reduce risk of
87 repetition as well as the burden on secondary care.[5-7]

88 An admission to hospital provides the 'teachable moment'. [8] That is,
89 both adolescents and their families may be more likely to engage with an
90 intervention than if they had received it elsewhere. Hospital-based
91 interventions to reduce the risk of future harm could benefit these adolescents
92 by reducing episodes of injury, and may reduce recurrent emergency (i.e.,
93 acute or unplanned) admissions for injury.

94 To date, there is a lack of evidence on how different types of adversity-
95 related injury occur in the same adolescents over time. In addition, policy
96 makers and service providers need to know how many adolescents have an
97 emergency admission to hospital for adversity-related injury, their
98 characteristics and their specific rates of re-admission if they are to be
99 feasibly targeted for intervention.

100 In this study we used administrative hospital data and Office for
101 National Statistics (ONS) mid-year population estimates to estimate the
102 number of adolescents in the general population who have ever had an
103 emergency admission to hospital for injury. We then estimated the

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6 104 prevalence of emergency admissions for injury related to violence, self-harm
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8 105 and drug or alcohol misuse (alone and co-occurring) in the general
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10 106 population. Finally, we determined the risk of recurrent emergency
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12 107 admissions for injury in adolescents who had at least one admission between
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14 108 10 and 19 years for adversity-related injury compared with adolescents only
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16 109 ever admitted for accidental injury during the same period.
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8 110 **METHODS**

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10 111 **Study population**

112 Using administrative data from all admissions to National Health Service
113 hospitals in England (Hospital Episode Statistics [HES]) in 1998-2011,[9] we
114 derived a retrospective cohort of adolescents who turned 10 years old in
115 1998-2002, who could be observed throughout adolescence until 19 years old
116 (Supplementary Table 1).[10] Each individual also had to have at least one
117 emergency admission for injury between 10 and 19 years old.

118 **Admission data**

119 The Health and Social Care Information Centre provided pseudonymised data
120 on hospital admissions, use of which did not require Research Ethics
121 Committee approval.[11] An admission is defined by the National Health
122 Service as any hospital case lasting longer than four hours, and so includes
123 long day cases as well as overnight stays. We analysed any hospital
124 transfers or admissions within one day after discharge as the same
125 admission, as previously described.[12] We used the variable for method of
126 admission ('admimeth') to define an emergency admission. We used all
127 International Classification of Diseases-10 (ICD-10) diagnosis codes recorded
128 during an admission to categorise admissions as being for injury related to
129 adversity or an accident (Supplementary Table 2).[13]

130 **Types of injury and age at emergency admission**

131 We defined an emergency admission for injury as being related to adversity,
132 comprising violence (maltreatment/assault/undetermined causes of injury),

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6 133 self-harm or drug or alcohol misuse, using mutually exclusive clusters of ICD-
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8 134 10 codes (Supplementary Table 2). Violence was defined by previously-
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10 135 validated codes, which would trigger consideration of violence by carers,
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12 136 peers or strangers.[12 14 15] We defined self-harm using codes that
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14 137 mentioned either 'self-harm' or 'self-poisoning'. Drug or alcohol misuse was
15
16 138 defined by codes that mentioned 'alcohol', 'drugs', 'noxious substance' or
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18 139 'solvent'. We defined an injury as being related to accidents only if no
19
20 140 adversity codes were present but there were codes from the ICD-10
21
22 141 *Accidents* subchapter (V01-X59).[13]

23
24 142 We grouped age at each admission to reflect age of onset of puberty
25
26 143 (10-14 years), age of sitting secondary school exams (15-17 years) and the
27
28 144 legal age for buying alcohol (18-19 years).[16-19]

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30 145 **Classification of adolescents according to types of injury and age at**
31
32 146 **emergency admissions**

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34 147 We classed adolescents into groups according to all of their emergency
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36 148 admissions for injury between 10 and 19 years old. Adolescents were
37
38 149 classed as belonging to the 'adversity' group (any adversity-related injury
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40 150 between 10 and 19 years old), 'accidents only' group (no adversity-related
41
42 151 injury but one or more accident-related injuries) or 'other causes' group (no
43
44 152 adversity-related or accident-related injuries) (Supplementary Figure 1).
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46 153 Among adolescents in the adversity group, we determined the proportion
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48 154 exposed to violence-, self-harm- and drug or alcohol misuse-related injury at
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50 155 age 10-19, respectively. We further classified the adversity group into seven
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52 156 mutually exclusive sub-groups: violence only, self-harm only, drug or alcohol
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54 157 misuse only, violence and self-harm, violence and drug or alcohol misuse,
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6 158 self-harm and drug or alcohol misuse, and violence, self-harm and drug or
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8 159 alcohol misuse.

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10 160 We also grouped adolescents as above, according to their emergency
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12 161 admissions for injury at 10-14 years only, 15-17 years only and 18-19 years
13
14 162 only (Supplementary Figure 2).

163 **Population denominators**

164 We used ONS mid-year population estimates to derive population
165 denominators.[20 21] These data are freely available online broken down by
166 sex and year of age.

167 **Analyses**

168 We estimated the proportion of adolescents in the general population who had
169 an emergency admission for injury between 10 and 19 years old. We used
170 the number of adolescents in our derived retrospective cohort as the
171 numerator and ONS mid-year estimates for 10 year olds in 1998-2002 as the
172 population denominator. We then calculated these proportions by types of
173 injury at 10-19 years old (adversity-related [adversity group and seven
174 mutually exclusive subgroups] and accidents only [accidents only group]) and
175 by age group, as described above.

176 We calculated the proportion of adolescents in the adversity group (and
177 subgroups) and in the accidents only group who had an emergency admission
178 for injury twice and three or more times between 10 and 19 years old. We
179 also calculated the proportions of adolescents with two or three or more
180 admissions of any type (including non-emergency and non-injury).

181 We reported all results separately for girls and boys since differences
182 between girls and boys have been reported for prevalence of adversity in the

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6 183 general population.[1 22-24] We calculated 95% confidence intervals for all
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8 184 proportions but did not present them here as they were all too narrow to
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10 185 convey any useful information (within one unit of the sample estimate).
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12 186 Analyses were carried out in StataSE 12.
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8 **187 RESULTS**

9
10 188 There were 1 033 702 adolescents in HES admissions data in 1998-2011, of
11 189 which 402 916 formed the study cohort (462 476 emergency admission for
12 190 injury when considering multiple presentations from the same adolescent, 802
13 191 682 admissions of any type [including non-emergency and non-injury, 662
14 192 727 of which were overnight stays]) (Table 1), representing 12.4% (402 916/3
15 193 254 046) of the adolescent population. Twice as many boys as girls had an
16 194 emergency admission for injury during adolescence (144 158/1 588 942 girls
17 195 in the population [8.7%]; 258 503/1 665 104 boys [16.3%]).
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196 **Table 1.** Characteristics of adolescents whose entire ten years of adolescence (ages 10-19) occurred in 1998-2011.
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Characteristics	Adolescent population*	Adolescents with emergency admission(s) for injury between 10 and 19 years old, n (row %)			
	Total	Total	Adversity	Accidents only	Other causes
All	3,254,046	402,916 (100.0)	141,248 (35.1)	233,907 (58.1)	27,761 (6.9)
Age**					
Girls	1,588,942	144,158 (100.0)	72,805 (50.5)	59,528 (41.3)	11,888 (8.2)
10-14 years	.	65,208 (100.0)	23,178 (35.5)	37,388 (57.3)	4,642 (7.1)
15-17 years	.	48,286 (100.0)	31,573 (65.4)	12,922 (26.8)	3,791 (7.9)
18-19 years	.	30,664 (100.0)	18,054 (58.9)	9,155 (29.9)	3,455 (11.3)
Boys	1,665,104	258,503 (100.0)	68,403 (26.5)	174,267 (67.4)	15,833 (6.1)
10-14 years	.	121,821 (100.0)	17,667 (14.5)	97,478 (80.0)	6,676 (5.5)
15-17 years	.	79,223 (100.0)	25,014 (31.6)	49,345 (62.3)	4,864 (6.1)
18-19 years	.	57,459 (100.0)	25,722 (44.8)	27,444 (47.8)	4,293 (7.5)
Missing (Sex)	.	255 (100.0)	40 (15.7)	175 (68.6)	40 (15.7)

198 *Based on ONS mid-year England statistics for 10 year olds in 1998-2002.[20]

199 **At first emergency admission for injury

200 **Types of injury and age at emergency admission**

201 One-third of the cohort (141 248, 4.3% of the population) had a record of an
202 emergency admission for adversity-related injury between 10 and 19 years
203 old (the adversity group; 157 004 emergency admissions for adversity-related
204 injury in total) (Table 1), with similar rates between sexes (72 805, 4.6% girls
205 in the population; 68 403, 4.1% boys).

206 The remaining two-thirds of the cohort (261 668, 8.1% of the
207 adolescent population) had emergency admissions for injury which were
208 never related to adversity (Table 1). Among these adolescents, 233 907
209 (89.4%) had an accident-related injury (the accidents only group, 7.2% of the
210 population) and 27 761 (10.6%) had no accident-related injury (other causes
211 group, 0.9% of the population). A high proportion of the other causes group
212 were affected by a chronic condition¹ between 10 and 19 years old (11 221/27
213 761, 40.4%), compared with the adversity group (45 321/141 248, 32.1%) or
214 accidents only group (49 434/233 907, 21.1%).

215 Proportions of adolescents in the general population and within
216 individual age groups by adversity [and subgroups], accidents only, and other
217 causes groups are provided in Supplementary Table 3.

218 **Types of adversity-related injury**

219 Among adolescents in the adversity group (girls 72 805, boys 68 403) (Figure
220 1), the most common type of adversity was drug or alcohol misuse (girls
221 91.5%, boys 60.0%). A higher proportion of boys than girls were exposed to

¹ Defined by ICD-10 codes (Supplementary Table 2)

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6 222 violence (girls 8.5%, boys 47.6%), but a higher proportion of girls than boys
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8 223 were exposed to self-harm (girls 74.6%; boys 32.9%).
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10 224 Girls in the adversity group were most likely to be exposed to multiple
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12 225 types of adversity between 10 and 19 years old (69.2% + 2.0% + 1.2% + 0.2%
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14 226 = 72.6%) (Figure 1), especially self-harm and drug or alcohol misuse (69.2%
15
16 227 of the entire adversity group, i.e., most of the 72.6%). Fewer boys in the
17
18 228 adversity group were exposed to multiple types of adversity (38.4%), the most
19
20 229 common combination also being self-harm and drug or alcohol misuse
21
22 230 (24.8%).
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24 231 For most of the adolescents who were exposed to multiple types of
25
26 232 adversity, the combination of types was recorded at the same admission. For
27
28 233 example, among the 130 adolescent girls who were exposed to violence and
29
30 234 self-harm between 10 and 19 years old (Table 2), 64.6% had both violence
31
32 235 and self-harm codes present simultaneously in at least one emergency
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34 236 admission for injury (violence and drug or alcohol misuse 78.8%, self-harm
35
36 237 and drug or alcohol misuse 99.7%, violence, self-harm and drug or alcohol
37
38 238 misuse 33.9%; boys: violence and self-harm 40.1%, violence and drug or
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40 239 alcohol misuse 84.1%, self-harm and drug or alcohol misuse 99.1%, violence,
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42 240 self-harm and drug or alcohol misuse 20.0%) (data not shown).
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Table 2. Proportion of adolescents with 1, 2 or 3+ emergency admission(s) for injury or 1, 2 or 3+ admission(s) of any type, by types of adversity between 10 and 19 years old*

Adolescent group*	No. girls	Girls (%)						Boys (%)						
		Emergency admission(s) for injury			Admission(s) of any type			Emergency admission(s) for injury			Admission(s) of any type			
		1	2	3+	1	2	3+	No. boys	1	2	3+	1	2	3+
All	144,158	88.6	8.3	3.1	57.6	20.5	22.0	258,503	90.3	8.0	1.8	68.5	18.7	12.9
Adversity	72,805	82.7	12.0	5.3	53.8	21.1	25.1	68,403	83.5	12.4	4.1	64.8	19.4	15.8
Any violence	6,211	77.2	13.9	8.9	49.1	20.7	30.1	32,799	83.2	12.8	4.0	65.6	19.6	14.8
Any self-harm	54,315	79.3	13.9	6.8	51.2	21.5	27.3	21,087	76.7	15.8	7.5	57.0	20.7	22.3
Any drug or alcohol misuse	66,645	81.9	12.5	5.6	53.6	21.1	25.3	41,014	81.1	13.6	5.3	62.9	19.5	17.6
Single adversity	19,924	92.8	6.2	1.0	61.2	19.8	19.0	43,563	71.3	8.3	1.8	55.8	15.2	10.3
Violence only	3,734	92.4	6.3	1.3	58.1	20.4	21.6	24,912	87.1	10.6	2.2	68.3	19.2	12.6
Self-harm only	2,296	90.3	8.1	1.6	54.4	20.7	24.9	2,260	87.3	10.4	2.3	62.3	19.8	17.9
Drug or alcohol misuse only	13,894	93.3	5.9	0.8	63.2	19.5	17.4	16,391	88.5	9.5	2.1	69.9	17.9	12.2
Multiple adversity	52,881	78.9	14.2	6.9	51.0	21.6	27.4	24,840	77.3	16.7	7.5	59.0	21.0	21.5
V + SH	130	70.0	20.8	9.2	42.3	26.2	31.5	217	41.6	15.4	6.1	32.8	16.0	14.2

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V + DA	862	81.9	15.1	3.0	52.2	22.9	24.9	6,013	84.6	17.5	5.4	68.4	21.8	17.3
SH + DA	50,404	80.1	13.7	6.3	51.8	21.6	26.6	16,953	86.7	16.4	6.9	64.6	22.7	22.9
V + SH + DA	1,485	36.8	31.6	31.5	25.5	19.9	54.5	1,657	22.0	16.4	14.1	17.9	11.7	22.8
No adversity	71,353	94.7	4.5	0.8	61.4	19.9	18.7	190,100	92.4	6.3	0.9	69.5	18.3	11.8
Accidents only	59,465	95.3	4.1	0.6	66.5	18.7	14.7	174,267	92.3	6.5	0.9	71.1	18.0	10.5
Other causes	11,888	91.5	6.3	2.1	35.5	25.8	38.8	15,833	93.4	5.0	1.6	51.5	22.1	26.3

243 V = Violence, SH = Self-harm, DA = Drug or Alcohol Misuse
 244 * Each adolescent classified by all adversity/accidents seen at any emergency admission(s) for injury between 10 and 19 years old.

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7 **245 Emergency re-admissions for injury**

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9 246 Adolescent girls in the adversity group (50.5% of all girls in the cohort)
10 247 accounted for 50.0% of the total number of emergency admissions for injury
11 248 coming from girls (data not shown), compared with girls in the accidents only
12 249 group (41.3% of all girls) who accounted for 36.6%. Boys in the adversity
13 250 group (26.2% of all boys in the cohort) accounted for 29.1% compared with
14 251 65.0% contributed by boys in the accidents only group (67.7% of all boys).

15 252 More adolescents in the adversity group were re-admitted for injury
16 253 (i.e., had two or more emergency admissions for injury) between 10 and 19
17 254 years old (girls 17.3%, boys 16.5%) (Figure 2), than in the accidents only
18 255 group (girls 4.7%; boys 7.4%). Among adolescents admitted for injuries
19 256 related to multiple types of adversity (Table 2), the proportion re-admitted was
20 257 even higher (multiple types: girls 21.1%, boys 24.2%; single type: girls 7.2%,
21 258 boys 10.1%).

22 259 Similarly, a higher proportion of adolescents in the adversity group had
23 260 two more admissions of any type (including non-emergency and non-injury)
24 261 between 10 and 19 years old (girls 46.2%; boys 35.2%) (Table 2) compared
25 262 with adolescents in the accidents only group (girls 33.4%; boys 28.5%). This
26 263 proportion was even higher for adolescents in the adversity group who were
27 264 admitted with multiple types of adversity (multiple types: girls 49.0%, boys
28 265 42.5%; single type: girls 38.8%, boys 25.5%).
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6 266 **DISCUSSION**

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8 267 More than one in 20 adolescents in England had at least one emergency
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10 268 admission for adversity-related injury between 10 and 19 years old. These
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12 269 adolescents accounted for a third of all adolescents with emergency
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14 270 admissions for injury and for a disproportionate number of re-admissions for
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16 271 injury, particularly adolescents admitted with multiple types of adversity-
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18 272 related injury. Targeting adolescents admitted with adversity-related injury
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20 273 could reduce their risk of future harm, the rate of re-admissions to hospital,
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22 274 and health care costs .[25]

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24 275 Longitudinally-linked admissions allowed us to study the entire ten
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26 276 years of adolescence in 402 916 individuals. We were able to distinguish
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28 277 between types of adversity that co-occurred during adolescence or at the
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30 278 same admission, and to study re-admissions. One weakness of this study
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32 279 was our reliance on diagnostic codes recorded in administrative data.
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34 280 Violence by carers, which could be coded under maltreatment, and drug or
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36 281 alcohol misuse have been shown to be under-recorded using ICD-10,[26 27]
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38 282 but false positives are rare.[15] To address under-recording, we used what
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40 283 we considered to be sensitive clusters of codes for adversity. Other factors
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42 284 related to recording or coding practices,[12 14 15 27 28] for example, new
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44 285 guidelines for defining maltreatment,[14] can also affect ascertainment.
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46 286 Because of the relative insensitivity but good specificity of the coding clusters,
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48 287 some adolescents who were classified in the accidents only group may in fact
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50 288 belong to the adversity group, but did not have their adversity recognised or
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52 289 recorded. Consequently, our prevalence estimates of admission for different
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54 290 types of adversity-related injury are likely to provide a lower bound for the true

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6 291 prevalence. Further, as adolescents exposed to adversity who attended the
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8 292 accident and emergency (A&E) department were not necessarily admitted,
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10 293 our prevalence estimates represent adolescents at the severe end of the
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12 294 adversity spectrum. Such analyses of A&E data are limited by the quality of
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14 295 these data in England (available since 2007) and the resulting problems with
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16 296 identifying reasons for presentation and accurately linking individuals to long-
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18 297 term outcomes.[29]

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20 298 Our prevalence estimates of admission for injury related to individual
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22 299 types of adversity from the general adolescent population are consistent with
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24 300 previous reports for emergency admissions for assault-related injury in 2004-
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26 301 2009 and for all admissions (emergency and non-emergency) for self-harm
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28 302 and drug or alcohol misuse.[1 2 24 30] Previous studies have reported higher
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30 303 rates of drug or alcohol misuse in boys than in girls in the general adolescent
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32 304 population.[24] We found higher rates in girls. This difference could indicate
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34 305 that girls exposed to drug or alcohol misuse are more likely to be injured, to
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36 306 present to hospital, or to be admitted after a hospital presentation, than boys.

37
38 307 Our estimated rates of re-admission of any type (including non-
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40 308 emergency and non-injury) for violence (girls 50.8%, boys 34.4%) (Table 2)
41
42 309 and self-harm (girls 48.8%, boys 43.0%) were higher than previously reported
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44 310 (11% for violence, 33% for self-harm).[3 4] These discrepancies are likely to
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46 311 be because we considered the whole ten years of adolescence and re-
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48 312 admission of any type, whereas previous studies looked at re-attendance up
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50 313 to the following year and for the same type of adversity-related injury.[3 4]

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52 314 The results of this study should inform policy initiatives and national
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54 315 guidelines. Firstly, a substantial proportion of adolescents are affected by

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6 316 adversity and they account for a large proportion (29.1 to 50.0%) of all
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8 317 emergency admissions to hospital for injury in this age group. Secondly, we
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10 318 show the large burden of injury admission for all three types of adversity, yet
11
12 319 there are currently no national clinical guidelines for managing cases of
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14 320 violence, other than responding to violence by caregivers.[31] Finally, these
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16 321 results show that adolescents often present with multiple types of adversity
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18 322 (especially in girls), even though guidelines exist only for managing individual
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20 323 problems.[32-34]

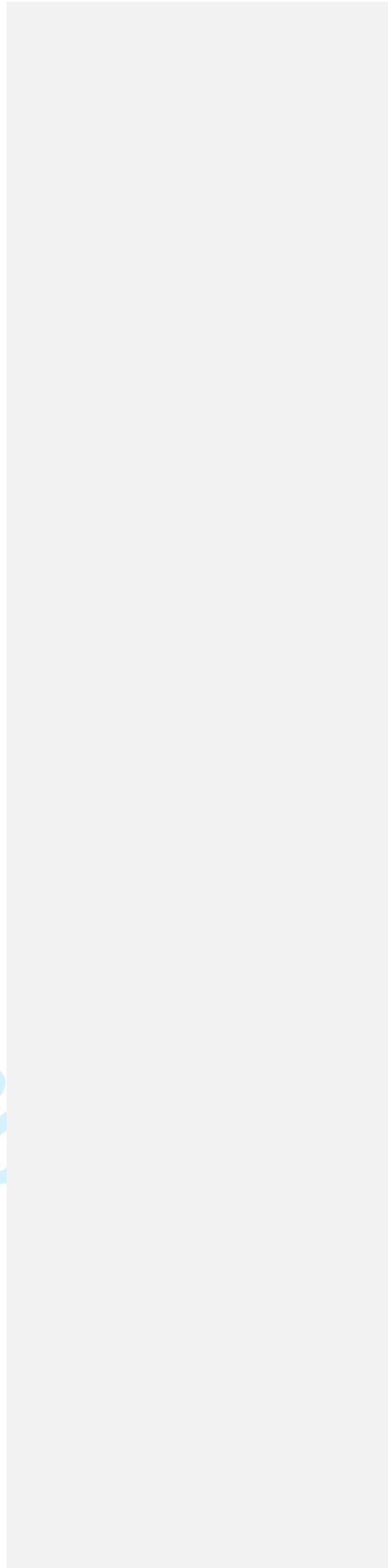
21
22 324 In addition, policy makers need to be aware of the widely varying
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24 325 aetiological pathways to admission with adversity-related injury. Our
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26 326 approach to defining this group of adolescents is not designed to reflect the
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28 327 complexity or severity of these cases. For example, admission for multiple
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30 328 types of adversity-related injury is a poor proxy indicator of severity. Effective
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32 329 interventions will need to be tailored to the individual based on specialist
33
34 330 clinical assessment. However, all three types of adversity are likely to reflect
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36 331 a combination of underlying psychosocial need and environmental and social
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38 332 stressors.[35]

39
40 333 Hospital interventions may reduce the risk of future harm, including the
41
42 334 incidence of other types of harm not seen in hospital, e.g., further adversity-
43
44 335 related injury not leading to admission. Further research using linked data
45
46 336 from health care sectors such as accident and emergency, could shed light on
47
48 337 the overall burden of adversity-related injury on hospitals. Though these data
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50 338 have limited quality in England. Such analyses are limited by the quality of
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52 339 accident and emergency data in England (available since 2007) and the
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54 340 resulting problems with identifying reasons for presentation and accurately

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341 | ~~linking individuals to long term outcomes.[29]~~ However, longitudinally-linked
342 datasets in other countries could provide insights into long-term outcomes for
343 this vulnerable group of adolescents.

For peer review only



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8 344 **Contributors**

9
10 345 Annie Herbert – helped to conceive and design the study, analysed and
11
12 346 interpreted the data, drafted the article, revised it critically for important
13
14 347 intellectual content and approved the final version to be published.

15
16 348 Leah Li – helped to conceive and design the study, interpreted the data,
17
18 349 revised the article critically for important intellectual content and approved the
19
20 350 final version to be published.

21
22 351 Arturo González-Izquierdo – helped to conceive and design the study,
23
24 352 acquired and interpreted the data, revised the article critically for important
25
26 353 intellectual content and approved the final version to be published.

27
28 354 Ruth Gilbert – helped to conceive and design the study, acquired and
29
30 355 interpreted the data, revised the article critically for important intellectual
31
32 356 content and approved the final version to be published.

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36
37 359

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7
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9
10 371 manuscript or the decision to submit the paper for publication, and the
11
12 372 authors' work was independent of their funders.

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16 374 **Ethics** Both Hospital Episode Statistics (HES) admissions data and Office for
17
18 375 National Statistics (ONS) mid-year population estimates are derived from
19
20 376 routinely collected administrative data. HES data were pseudonymised
21
22 377 before we received them and therefore we did not require Research Ethics
23
24 378 Committee approval.

25
26 379

27
28 380 **Data sharing** No additional data on HES are available. ONS mid-year
29
30 381 population estimates may be accessed freely online:

31
32 382 [http://www.ons.gov.uk/ons/publications/all-](http://www.ons.gov.uk/ons/publications/all-releases.html?definition=tcm%3A77-22371)
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34 383 [releases.html?definition=tcm%3A77-22371](http://www.ons.gov.uk/ons/publications/all-releases.html?definition=tcm%3A77-22371).

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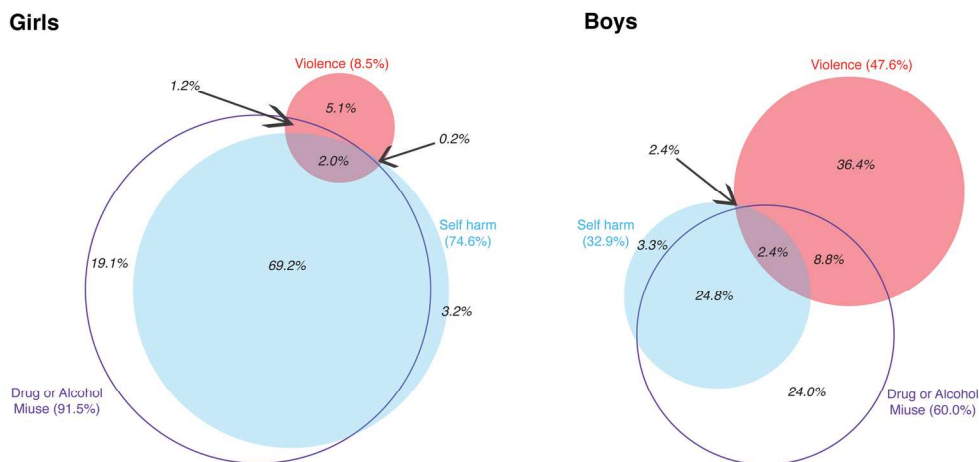
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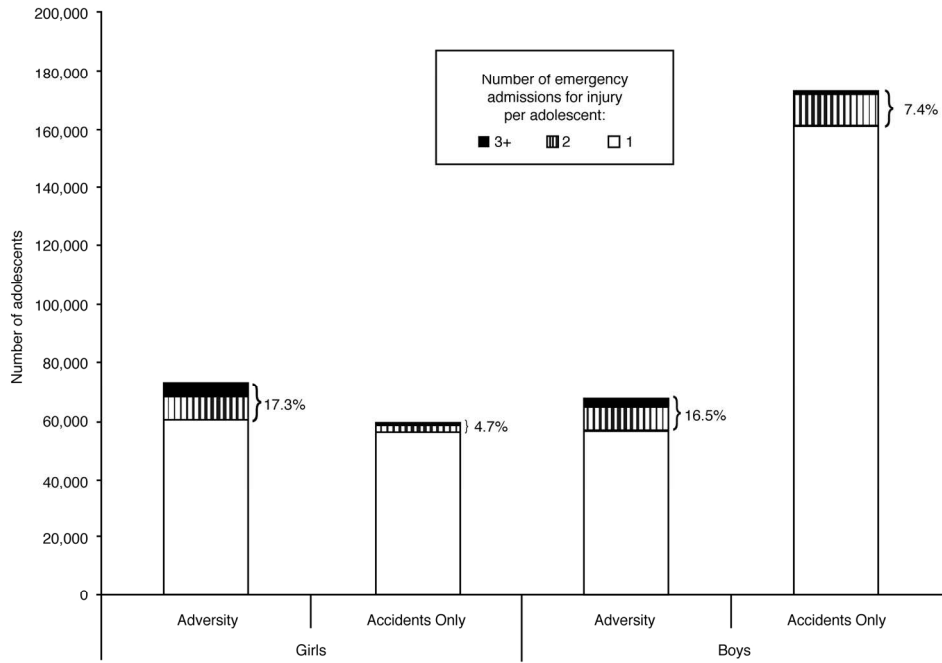


Number (%) of adolescents with adversity-related injury, by types of adversity between 10 and 19 years old* and sex

*Each adolescent classified by all adversity recorded at any emergency admission(s) for injury between 10 and 19 years old
173x86mm (300 x 300 DPI)

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Number of adolescents with 1, 2 and 3 or more emergency admission(s) for injury between 10 and 19 years old*, by types of injury between 10 and 19 years old** and sex

*Percentages are of adolescents who have 2 or more emergency admissions for injury between 10 and 19 years old

**Each adolescent was classified by all adversity/accidents recorded at any emergency admission(s) for injury
173x125mm (300 x 300 DPI)

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Supplementary Tables

Supplementary Table 1. Cohort (shaded) who have at least one emergency admission for injury between 10 and 19 years old in 1998-2011 (N = 402,916)

1998	1999	2000	2001	2002	...	2007	2008	2009	2010	2011
6	7	8	9	10	...	15	16	17	18	19
7	8	9	10	11	...	16	17	18	19	20
8	9	10	11	12	...	17	18	19	20	21
9	10	11	12	13	...	18	19	20	21	22
10	11	12	13	14	...	19	20	21	22	23

Supplementary Table 2. Definitions and International Classification of Diseases (ICD-10) diagnostic codes used to classify emergency admissions for injury, chronic conditions and types of adversity*

ADMISSIONS AND ADMISSION TYPES

Admission

Admissions were defined by linked episodes of inpatient care, including day cases (any case > 4 hours stay). Any admission which occurred within one day or was a hospital transfer from a previous admission was considered to be the same admission. An episode may have up to 20 diagnosis codes entered, but 88% of admissions in this cohort had episodes with four or less diagnoses recorded (data not shown).

Emergency (acute; unplanned) admission

An admission was considered to be an emergency if the method of admission variable ('admimeth') was 21-24 or 28.(1)

Injury

An admission was considered to be for injury if any of the diagnosis codes in the first episode of the admission were S or T codes (Chapter XIX of the ICD -10).

CHRONIC CONDITIONS

ICD-10 codes as per Hardelid et al, 2013,(2) excluding E24.4, F10-F19, G31.2, G40.5, G62.1, G72.1, K29.2, K70, K85.2, K86.0, O35.4, R78.1-R78.5, Z50.2, Z50.3, Z86.4, X64-X84, Y10-Y34, Z91.5, F30.0-F30.2, F30.8-F32.3, F32.8-F334, F33.8-F34.1, F34.8-F34.9, F38.0-F38.1, F38.8, F39-F40.2, F40.8- F41.3, F41.8-F41.9.

ADVERSITY CLUSTERS AND DESCRIPTIONS*

ICD-10 CODES

Violence

Maltreatment

Maltreatment syndromes

T74

Effects of other deprivation (extreme neglect)

T73

Perpetrator of neglect and other maltreatment syndromes

Y06, Y07

Assault

Assault by bodily force and sexual assault

Y04, Y05

Other types of assault

X85 - Y03, Y08 - Y09

Undetermined cause

Events of undetermined intent

Y20 - Y34

Examination and observation following other inflicted injury

Z04.5

Examination and observation for other reasons: request

Z04.8

for expert evidence

Self-harm

Intentional self-poisoning by and exposure to...

...drugs

X60-X63

...other and unspecified drugs, medicaments and

X64

biological substances

...alcohol

X65

...organic solvents and halogenated hydrocarbons and

X66

their vapours

...other gases and vapours

X67

...pesticides

X68

...other and unspecified chemicals and noxious

X69

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3	substances	
4	<i>Intentional self-harm by...</i>	
5	...hanging, strangulation and suffocation	X70
6	...drowning and submersion	X71
7	...firearm discharge	X72-X74
8	...explosive material	X75
9	...smoke, fire and flames, or steam, hot vapours and hot	
10	objects	X76-X77
11	...sharp/blunt objects	X78-X79
12	...jumping from a high place	X80
13	...jumping or lying before a moving object, or crashing a	
14	motor vehicle	X81-82
15	...other specified means	X83
16	...unspecified means	X84
17	<i>Personal history of self-harm</i>	Z91.5
18		
19		
20		
21	Drug or alcohol misuse	
22	<i>Drugs, medicaments and biological substances (illicit drugs)</i>	
23	Mental and behavioural disorders due to psychoactive	
24	substance use	F11 - F17, F19
25	Finding of drugs not normally found in blood	R78.1 - R78.5
26	Poisoning by drugs, medicaments and biological	T36 - T50
27	substances	(not including T50.6)
28	Poisoning, undetermined intent	Y10 - Y14
29	Drug rehabilitation	Z50.3
30	Drug abuse counselling and surveillance	Z71.5
31	Drug use	Z72.2
32	<i>Environmental/ Domestic substances</i>	
33	Mental and behavioural disorders due to use of volatile	
34	solvents	F18
35	Accidental poisoning by and exposure to noxious	
36	substances	X40 - X44, X46 - X49
37	Intentional self-poisoning by and exposure to noxious	
38	substances	X69
39	Poisoning by chemical or noxious substance,	
40	undetermined intent	Y16 - Y19
41	<i>Codes mentioning both alcohol and drugs</i>	
42	Special epileptic syndromes - (related to alcohol, drugs,	
43	etc.)	G40.5
44	Blood-alcohol and blood-drug test	Z04.0
45	<i>Alcohol</i>	
46	Alcohol-induced pseudo-Cushing's syndrome	E24.4
47	Mental and behavioural disorders due to use of alcohol	F10
48	Degeneration of nervous system due to alcohol	G31.2
49	Alcoholic polyneuropathy	G62.1
50	Alcoholic myopathy	G72.1
51	Alcoholic cardiomyopathy	I42.1
52	Alcoholic gastritis	K29.2
53	Alcoholic liver disease	K70
54	Alcohol-induced acute pancreatitis	K85.2
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3	Alcohol-induced chronic pancreatitis	K86.0
4	Maternal care for (suspected) damage to fetus from	
5	alcohol	O35.4
6		
7		
8	Finding of alcohol in blood	R78.0
9	Poisoning: antidotes and chelating agents, not elsewhere	
10	classified	T50.6
11	Toxic effect of alcohol	T51
12	Accidental poisoning by exposure to alcohol	X45
13		
14		
15	Poisoning by exposure to alcohol, undetermined intent	Y15
16	Evidence of alcohol involvement determined by blood	
17	alcohol level	Y90
18	Evidence of alcohol involvement determined by level of	
19	intoxication	Y91
20	Alcohol rehabilitation	Z50.2
21	Alcohol abuse counselling and surveillance	Z71.4
22	Alcohol use	Z72.1
23		
24		
25	Accidents	
26	Transport accidents	V01 - V99
27	Falls	W00 - W19
28	Exposure to inanimate mechanical forces	W20 - W49
29	Exposure to animate mechanical forces	W50 - W64
30	Accidental drowning and submersion	W65 - W74
31	Other accidental threats to breathing	W75 - W84
32	Exposure to electric current, radiation and extreme	
33	ambient air temperature and pressure	W85 - W99
34	Exposure to smoke, fire and flames	X00 - X09
35	Contact with heat and hot substances	X10 - X19
36	Contact with venomous animals and plants	X20 - X29
37	Exposure to forces of nature	X30 - X39
38	Accidental poisoning by and exposure to noxious	
39	substances	X40 - X49
40	Overexertion, travel and privation	X50 - X57
41	Accidental exposure to other and unspecified factors	X58 - X59
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Supplementary Table 3. Population prevalence* (per 100,000) of emergency admission(s) for injury, by types of adversity within age periods** and sex

	All girls	All boys	Girls			Boys		
Adolescent group**	10-19y	10-19y	10-14y	15-17y	18-19y	10-14y	15-17y	18-19y
All	9,073	16,333‡	4,104	3,260§	2,189§	7,316‡	5,069‡§	3,852‡§
Adversity	4,582	4,108‡	1,240	2,124§	1,329§	669‡	1,458‡§	1,748‡§
Any violence	391	1,970‡	103	152§	110	277‡	731‡§	833‡§
Any self-harm	3,418	1,266‡	777	1,463§	923§	170‡	393‡§	478‡§
Any drug or alcohol misuse	4,194	2,463‡	1,112	1,959§	1,221§	375‡	807‡§	1,077‡§
Single adversity	1,254	2616‡	495	687§	412§	516	991‡§	1,114‡§
Violence only	235	1,496‡	77	99§	75	256‡	609‡§	635‡§
Self-harm only	144	136	48	63§	31§	37‡	39	34
Drug or alcohol misuse only	874	984‡	369	525§	305§	224‡	342‡§	445‡§
Multiple adversity	3,328	1,492‡	745	1,436§	917§	153‡	467‡§	634‡§
V+SH	8	13‡	3	3	1§	1‡	2	2
V+DA	54	361‡	17	37§	26§	19	114‡§	190‡§
SH+DA	3,172	1,018‡	720	1,384§	882§	131‡	345‡§	436‡§
V+SH+DA	93	100‡	6	13§	8	2‡	5‡§	6§
No adversity	4,491	11,417‡	2,676	1,136§	860§	6,648‡	3,611‡	2,171‡§
Accidents only	748	10,466‡	2,221	804§	580§	5,887‡	3,109‡	1,784‡§
Other causes	3,742	951‡	455	332§	279§	761‡	503‡	388‡§

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V = Violence, SH = Self-harm, DA = Drug or Alcohol Misuse

*Due to large denominators, confidence intervals for population prevalence were too narrow to provide any meaningful interpretation and so are not shown.

**Each adolescent classified by all adversity/accidents seen at any emergency injury admission(s) at 10-19 years, 10-14 years, 15-17 years and 18-19 years, respectively.

‡Statistically significantly different from girls of the same age (according to 95% confidence intervals).

§Statistically significantly different from 10-14 year olds of the same sex (according to 95% confidence intervals).

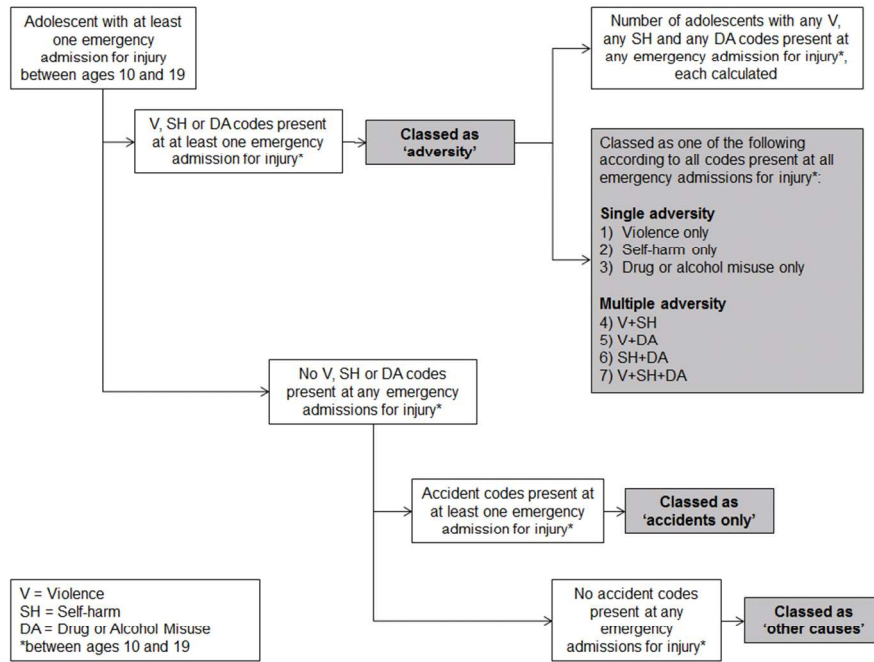
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1. Inpatient HES Data Dictionary. Leeds: Health and Social Care Information Centre, 2010.
2. Hardelid P DN, Davey J, Primbramska I, Gilbert R. Overview of child deaths in the four UK countries. London: 2013.

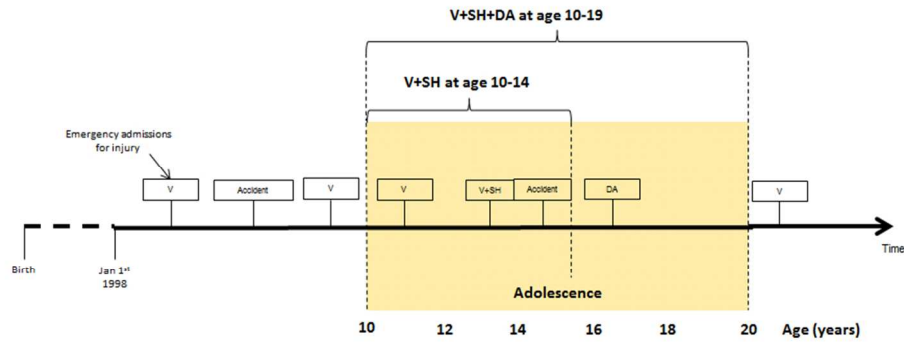
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Classification of groups of adolescents.
282x212mm (96 x 96 DPI)

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Supplementary Figure 2. Example of classification of groups of adolescents within age groups and across adolescence (ages 10-19).

V = victimisation, SH = self-harm, DA = drug or alcohol misuse.
 254x102mm (96 x 96 DPI)

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STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract (b) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported
Objectives	3	State specific objectives, including any prespecified hypotheses
Methods		
Study design	4	Present key elements of study design early in the paper
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants	6	(a) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up <i>Case-control study</i> —Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants (b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed. N/A <i>Case-control study</i> —For matched studies, give matching criteria and the number of controls per case
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
Bias	9	Describe any efforts to address potential sources of bias. We only analysed those who could be observed between ages 10 and 19, so no bias due to different lengths of admission trajectories.
Study size	10	Explain how the study size was arrived at. All available administrative data.
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding (b) Describe any methods used to examine subgroups and interactions (c) Explain how missing data were addressed. N/A (d) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed. We only analysed those who could be observed between ages 10 and 19. <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed <i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy (e) Describe any sensitivity analyses. N/A

Continued on next page

Results

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed (b) Give reasons for non-participation at each stage. <i>N/A</i> (c) Consider use of a flow diagram. <i>We didn't use a flow diagram as eligibility could be described using one sentence.</i>
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (b) Indicate number of participants with missing data for each variable of interest (c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount). <i>N/A</i>
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time. <i>We state how many emergency admissions for adversity-related injury the adversity group had. We also provide a table indicating the number of emergency admissions for injury and admissions (of any type) during ages 10-19.</i> <i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure <i>Cross-sectional study</i> —Report numbers of outcome events or summary measures
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included. <i>We gave prevalence estimates stratified by age-group and sex.</i> (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period. <i>N/A</i>
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions; and sensitivity analyses

Discussion

Key results	18	Summarise key results with reference to study objectives
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability	21	Discuss the generalisability (external validity) of the study results

Other information

Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based
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*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.