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1 **Causes of death up to ten years after hospitalisation for self-**  
2 **inflicted, drug/alcohol-related, or violent injury during**  
3 **adolescence: a nationwide cohort study**

4

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6

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18

19 Abstract: 318 (limit 300)

20 Manuscript: 3,645 (limit 3,000)

21 Tables: 3

22 Figures: 3

23 Supplementary materials: 3 tables, 1 figure

24 References: 30 (limit 30)

## 25 **Summary**

26

27 **Background:** Emergency hospital admission with adversity-related injury (self-inflicted,  
28 drug/alcohol-related, violent) affects 4% of 10-19 year olds. Their risk of death in the  
29 decade after discharge is twice as high compared to adolescents hospitalised for accident-  
30 related injury. We determined how cause of death varied between these groups.

31 **Methods:** We compared risks of death in five causal groups (suicide, drug/alcohol-related,  
32 homicide, accidental, 'other') up to ten years after discharge following adversity-related or  
33 accident-related injury. We used linked hospital admission (to the National Health Service)  
34 and mortality data for England (1997-2012) to determine cause-specific risks of death for  
35 10-19 year olds, and to compare risks between adversity- and accident-related index injury  
36 after adjustment for age-group, socio-economic status, and chronic conditions.

37 **Findings:** Among 333,009 adolescents admitted with adversity-related injury (girls  
38 181,926, boys 181,053), and 649,818 with accident-related injury (girls 166,462, boys  
39 483,356), 4,782 died in the ten years post-discharge (girls 1,312, boys 3,470). Adolescents  
40 discharged after adversity-related injury had higher risks of suicide and of drug/alcohol-  
41 related death in the next decade than after accident-related injury (adjusted hazard ratios  
42 [aHRs] varied from 3.2 [95% CI: 2.7, 3.6] for suicide in boys to 4.7 [3.3, 6.8] for  
43 drug/alcohol-related death in girls). Risks of suicide were increased following self-inflicted  
44 injury, drug/alcohol related injury, and violent injury (e.g. boys, aHR: 6.2 [5.3, 7.3], 4.5  
45 [3.9, 5.2], 1.4 [1.2, 1.8], respectively vs. accident-related injury). Following each type of  
46 index injury, risks of suicide and risks of drug/alcohol-related death were increased by  
47 similar magnitudes (e.g. boys with self-inflicted injury vs. accident-related injury, aHR of  
48 suicide: 6.2 [5.3, 7.3], drug/alcohol-related injury death: 5.9 [5.0, 7.0]).

49 **Interpretation:** Risks of suicide increased after all types of adversity-related injury, as did  
50 risks of drug/alcohol-related death by a similar magnitude. Current practice to reduce risks  
51 of harm after self-inflicted injury should be extended to drug/alcohol-related and violent  
52 injury in adolescence. Prevention should address the substantial risks of drug/alcohol-  
53 related death alongside risks of suicide.

54

55 **Funding:** Department of Health Policy programme (reference 109/00017).

## 56 **Introduction**

57 Evidence from population-based cohort studies suggests that different types of  
58 ‘adversity-related injury’ (self-inflicted [including poisonings], drug/alcohol-related, or  
59 violent injury) during adolescence are associated with similar underlying psychosocial  
60 problems, including adverse experiences (e.g. maltreatment), poor mental health (e.g.  
61 anxiety, depression), and poor social circumstances (e.g. poverty).<sup>1-3</sup> Among the 4% of  
62 adolescents (10-19 year olds) who are admitted to hospital with one of these types of  
63 adversity-related injury in England, approximately three-quarters of girls and one-third  
64 of boys are admitted with injuries related to multiple types of adversity.<sup>4</sup> Despite this  
65 apparent overlap between self-inflicted, drug/alcohol-related, and violent injury, most  
66 research in these adolescents has focused on specific types of adversity-related injury.  
67 A previous study of adolescents admitted to hospital in England as an emergency with  
68 any adversity-related injury reported that 1 in 136 girls (7.3 per 1,000) and 1 in 64 boys  
69 (15.6 per 1,000) died within the ten years after discharge, and that these risks were  
70 similar whether the initial injury was self-inflicted, drug/alcohol-related, or violent.<sup>5</sup>  
71 These ten-year risks were approximately twice the risks for adolescents discharged after  
72 accident-related injury (girls 3.8 per 1,000 and boys: 6.0 per 1,000) or for the general  
73 population of adolescents (girls 3.0 and boys: 3.0).

74

75 Despite common underlying psychosocial problems and elevated mortality risks among  
76 adolescents with any of these three types of adversity-related injury, UK national  
77 clinical guidelines recommend different approaches to psychosocial assessment and  
78 intervention to reduce future harm.<sup>6-8</sup> For example, guidelines for managing self-  
79 inflicted injury presenting to hospital recommend admission of patients younger than  
80 16 years and assessment of psychosocial circumstances and suicide risk at all ages.<sup>6,7</sup>  
81 Guidelines for drug- or alcohol- related presentations do not specifically address  
82 psychosocial needs of adolescents.<sup>8</sup> No UK guidelines exist for responding to violent  
83 injury. A further issue is that clinical management to reduce the risk of further harm  
84 after self-inflicted injury focuses on risks of recurrent self-harm, despite evidence for  
85 increased risks of other adverse outcomes.<sup>9</sup> A cohort study of 15-24 year olds  
86 presenting to a hospital in Oxford with self-inflicted injury in 1978-1997 reported  
87 increased mortality due to respiratory disorders, circulatory disorders, and accidents, as

88 well as suicide, during the subsequent 20 years.<sup>9</sup> No comparable estimates have been  
89 published for risks of harm following drug/alcohol-related or violent injury (see panel  
90 ‘Research in Context’).

91

92 This study aims to inform preventive strategies for reducing risks of future harm for  
93 adolescents who are discharged from hospital after self-inflicted, drug/alcohol-related,  
94 or violent injury. Given standard practice to reduce risks of repeated self-harm or  
95 suicide after discharge following self-inflicted injury, we examined, for girls and boys  
96 separately, whether risks of suicide difference between adolescents discharged  
97 following drug/alcohol-related and violent injury. Second, among girls and boys  
98 respectively, we compared risks of cause-specific death (suicide, drug/alcohol-related,  
99 homicide, accidental, and other) up to ten years from discharge after each type of index  
100 injury, including accident-related injury.

101

102

## 103 **Methods**

### 104 **Study design**

105 We used Hospital Episode Statistics (HES) data, which contain all emergency (acute,  
106 unplanned) admissions to the National Health Service (NHS) in England (April 1997-  
107 March 2012), including to independent sector providers paid for by the NHS.<sup>10</sup>  
108 Approximately 98-99% of hospital activity in England is funded by the NHS,<sup>11</sup> and so  
109 these data captured nearly all admitted adolescents. As we used a standard, de-identified  
110 HES extract from NHS Digital (formerly known as the Health and Social Care  
111 Information Centre), ethics approval was not required.<sup>12</sup>

112 We derived a cohort of adolescents (aged 10-19 years inclusive) who were admitted for  
113 injury (the index injury), and categorised them as ‘adversity-related injury’ (comprising  
114 non-mutually exclusive groups of self-inflicted, drug/alcohol-related, or violent injury;  
115 irrespective of whether the injury was also accident-related) or ‘accident-related injury’  
116 (where there was no recorded adversity-related injury). Therefore, adversity-related  
117 injury and accident-related injury were two mutually exclusive groups. Deaths within  
118 the cohort were evaluated in five ‘causal’ groups: suicide, drug/alcohol-related,

119 homicide, accidental, or 'other'. We compared risks of death (total and by cause) up to  
120 ten years following discharge from admission for adversity-related injury (exposure)  
121 with risks after accident-related injury (comparator).

122

123

124 We excluded adolescents who did not have sex recorded (885; 0.08%), died during the  
125 index admission (1,877; 0.17%), had no valid discharge date (372; 0.03%), or were  
126 admitted with injury related to neither adversity nor accidents (94,407; 8.9%; the  
127 majority of these latter adolescents were admitted primarily for chronic conditions or  
128 complications of surgery).<sup>4</sup>

### 129 **Study cohort and exposures**

130 Self-inflicted, drug/alcohol-related, violent, and accident-related injuries were  
131 identified using ICD-10 codes in HES data (i.e. characteristics that were identified and  
132 recorded by clinicians). Details of classification of injury and descriptive statistics of  
133 the cohort have been reported elsewhere.<sup>4,5</sup> Briefly, 333,009 adolescents who had at  
134 least one adversity-related injury (181,926 girls, 151,083 boys; 20.3% and 24.0% of  
135 which had an injury that was also accident-related), and 649,818 with at least one  
136 accident-related injury but no adversity-related injury (166,462 girls, 483,356 boys)  
137 were identified (Supplementary Figure S1).<sup>5</sup>

138

139 Table 1 shows that the most frequent type of injury among girls and boys was  
140 drug/alcohol-related followed by self-inflicted injury in girls and violent injury in boys.  
141 We have previously reported that the peak age group for adversity-related injury was  
142 15-17 years old for girls (47%) and 18-19 years old for boys (46%), but for accident-  
143 related injury it was 10-14 years for girls (62%) and boys (54%). Compared with  
144 adolescents admitted with accident-related injury, those admitted for adversity-related  
145 injury were more likely to be in the in the most deprived category, or to have a chronic  
146 condition recorded in the past year in hospital records (Herbert *et al* 2015, Table 1).<sup>5</sup>

147

148 **Outcomes**

149 The primary outcome was cause-specific death between one day and ten years after  
150 discharge from the index injury admission. We identified deaths using Office for  
151 National Statistics (ONS) mortality data linked to HES (within NHS Digital). We used  
152 any ICD-9 or -10 codes in the mortality data (based on the underlying and up to 15  
153 other contributing causes recorded in the death certificate) to categorise deaths into five  
154 ‘causal’ groups (Supplementary Table S1). As Figure 1 illustrates, suicide,  
155 drug/alcohol-related, and homicide were not mutually exclusive, but these three groups  
156 (i.e. adversity-related deaths), accidental (no codes for adversity-related death, but  
157 codes for accidental causes) and ‘other’ deaths (no codes for adversity-related or  
158 accidental deaths) were mutually exclusive. As advised by the ONS, undetermined  
159 causes of death (codes E980-E989, Y1-Y34; n=483) were classified as suicide  
160 (accounting for 38.1% of all suicides).<sup>13</sup> Deaths with codes indicating an adjourned  
161 inquest (U50.9; n=130) were categorised as homicide (80.2% of all homicides).

162

163 Demographic and clinical factors

164 Covariates were included in the analyses, based on previous findings of their  
165 relationship with adversity-related injury and death, including sex, age, socio-economic  
166 status (SES), and chronic conditions.<sup>5</sup> Age was grouped (10-15, 16-17, 18-19 years) to  
167 reflect different recommendations in UK national guidelines for management of self-  
168 harm or alcohol misuse according to age, and different stages of social development.<sup>6-  
169 8</sup> SES was categorised according to Index of Multiple Deprivation scores based on  
170 residential postcode,<sup>14</sup> using quintile cut-off values for England. An adolescent was  
171 classified as having an underlying chronic condition if HES records for the index injury  
172 admission or any admissions in the previous year included one of a cluster of ICD-10  
173 codes for chronic conditions (Hardelid *et al*, 2013; Appendix Table 6.3.2).<sup>15</sup> Of the  
174 117,453 adolescents with adversity-related or accident-related injury who had a chronic  
175 condition, 93,592 (79.7%) had a physical condition (data not shown). The most  
176 common physical condition was chronic respiratory disorder (e.g. asthma, 39.8% to  
177 55.4% by sex and type of injury).<sup>5</sup>

178

179 **Statistical analyses**

180 All analyses were conducted in Stata/SE 12 (StataCorp), and separately for girls and  
181 boys.

182

183 We first derived numbers (and proportions) of deaths (total and by cause) in the ten  
184 years post-discharge after adversity-related (self-inflicted, drug/alcohol-related, or  
185 violent) or accident-related index injury. As statistical disclosure rules required us not  
186 to publish counts <10 we did not present exact numbers of homicides for certain groups.

187

188 We determined unadjusted cumulative risks and 95% confidence intervals (CIs) of  
189 deaths for each cause of death over the ten years following discharge from the index  
190 injury admission, using the number of adolescents discharged alive after each type of  
191 index injury as the denominator. The cumulative risk of death by cause of death was  
192 estimated as a cumulative incidence function, which accounted for other ‘competing’  
193 causes (e.g. for suicide, competing causes included homicide, drug/alcohol-related,  
194 accidental and other).<sup>16</sup> For reference, we present unadjusted ten-year cumulative risks  
195 and 95% CIs by cause of death and type of index injury, sex, and age-group  
196 (Supplementary Table S2). We also estimated total and cause-specific risks of death for  
197 the general population of 10-19 year olds in England in 1997-2012, using publicly  
198 available ONS life-tables for total mortality and suicide, and bespoke life-tables for  
199 drug/alcohol-related and accidental deaths provided to us by the ONS (according to  
200 ICD codes in Supplementary Table S1).<sup>17-19</sup>

201

202 We fitted Fine & Gray models<sup>16</sup> to estimate the relative risks of total and cause-specific  
203 mortality following adversity-related index injury, adjusted for covariates and taking  
204 into account competing risks of other causal groups. The exposure was type of index  
205 injury, and covariates included age-group, SES, and chronic condition status. ‘Sub-  
206 hazard ratios’ (SHRs) of each cause of death were estimated for adversity-related injury  
207 (vs. accident-related injury), age-groups 16-17 and 18-19 years (vs. 10-15 years), each  
208 level of SES (vs. least deprived), and chronic condition (vs. none). To compare risks  
209 following each type of adversity-related injury, we fitted the models as above but where

210 the exposure was self-inflicted, drug/alcohol-related, and violent injury, respectively  
211 (each vs. accident-related injury).

212

213 Finally, we assessed whether the finding that increased risks of suicide and  
214 drug/alcohol-related deaths following self-inflicted or drug/alcohol-related injury was  
215 due to the ‘overlap’ between these two types of index injury (73% of girls and 44% of  
216 boys with either type had both types),<sup>5</sup> or the overlap between suicide and drug/alcohol-  
217 related deaths (~12% of deaths that were either suicide or drug/alcohol-related, were  
218 both [Figure 2]). We fitted the Fine & Gray models as above, but where the exposure  
219 was the three different combinations of self-inflicted and drug/alcohol-related injury  
220 (vs. accident-related injury), and the outcome was suicide, drug/alcohol-related death,  
221 and each combination of these types of death, respectively (further details within  
222 footnotes of Supplementary Table S3).

223

224 We checked model assumptions using log-log plots of the Kaplan-Meier estimate of  
225 the survival function and the link test, and assessed their goodness-of-fit using plots of  
226 the Nelson-Aalen estimate of the cumulative hazard function against Cox-Snell  
227 residuals.<sup>16</sup>

228

229

## 230 **Results**

231 By ten years after discharge from admission for the index injury, there were 2,415  
232 deaths (girls 873, boys 1,542) after adversity-related injury and 2,367 deaths (girls 439,  
233 boys 1,928) after accident-related injury (Figure 1, Table 1). After adversity-related  
234 index injury, nearly two-thirds (63·9%, n=1,046) of the deaths were related to suicide,  
235 drug/alcohol use, or homicide, compared with only one-third (33·6%, n=796) after  
236 accident-related index injury (Figure 1, Table 1). The proportions of deaths related to  
237 suicide, drug/alcohol use, or homicide, respectively, were also higher after admission  
238 for adversity-related injury compared with after accident-related injury (Figure 1, Table  
239 1). The proportions of deaths related to suicide, drug/alcohol use, or homicide were  
240 similar between girls and boys after adversity-related injury (girls 59·3% [n=518], boys  
241 66·5% [n=1,025]), but lower for girls than boys after accident-related injury (girls

242 19.4% [n=85], boys 36.9% [n=711]) (Table 1). The most frequent causes of death after  
243 accident-related index injury were ‘other’ (overall 37.1% [n=877]; girls 59.2%  
244 [n=260], boys 32.0% [n=617]) and accidental (29.3% [n=694]; girls 21.4% [n=94],  
245 boys 31.1% [n=600]) (Figure 1, Table 1).

246

247 Two thirds of all accidental deaths, 67.8% (n=759) were recorded as transport  
248 accidents; this proportion did not differ according to type of index admission (data not  
249 shown). Among deaths due to other causes, the most common causes were related to  
250 neurological conditions (30.9%, n=473) or cancer/blood disorders (25.1%, n=384; of  
251 nine possible groups of ICD codes relating to systems within the body).<sup>15</sup>

252

### 253 **Risks of total and cause-specific deaths by type of index injury**

#### 254 *Adversity-related vs. accident-related index injury*

255 Ten-year cumulative risks of total death after adversity related index injury were 7.3  
256 per 1,000 (or 1 per 137) girls (95% CI: 6.8 to 7.8 per 1,000) and 15.6 per 1,000 (or 1  
257 per 64) boys (14.8 to 16.4 per 1,000) (Figure 2, Supplementary Table S2). Cumulative  
258 risks were lower after accident-related index injury (girls 3.7 per 1,000, 3.4 to 4.1; boys  
259 6.0, 5.7 to 6.3).

260

261 The increased risks of death after an adversity-related compared with accident-related  
262 injury were due to substantially higher risks of suicides and drug/alcohol-related deaths  
263 at all time-points after the index injury (Figure 2). After adjustment for other covariates,  
264 risks of suicides and drug/alcohol-related deaths were three to five times higher  
265 following discharge from adversity-related injury admission (Table 2).

266

#### 267 *Self-inflicted, drug/alcohol-related, and violent index injury*

268 Ten-year risks of suicide were similar after hospital discharge following self-inflicted  
269 index injury and drug/alcohol-related index injury (girls 2.9 vs. 2.5 per 1,000; boys 9.8  
270 vs. 7.2; Figure 3, Supplementary Table S2). Compared with adolescents discharged  
271 after accident-related injury, risks of suicide were increased five- to six-fold for

272 adolescents discharged after self-inflicted or drug/alcohol-related injury (Table 3 shows  
273 sub-hazard ratios adjusted for covariates; e.g. for boys the adjusted SHR of suicide after  
274 self-inflicted injury was 6.20 [5.27, 7.30] and after drug/alcohol-related injury 4.51  
275 [3.89, 5.24]). Risks of suicide were increased after self-inflicted and after drug/alcohol-  
276 related injury, whether the index injury was for either one of these types of injury only,  
277 or both (Supplementary Table S3; i.e. comparing between rows, per sex).

278

279 Ten-year risks of suicide and of drug/alcohol-related death were similar after each type  
280 of index injury. These risks were highest after self-inflicted or drug/alcohol-related  
281 index injury (Figure 3; Supplementary Table S2). For example, after self-inflicted  
282 injury, the ten-year risk of suicide for girls was 2.9 per 1,000, whereas the ten-year risk  
283 of drug/alcohol-related death was 2.7 per 1,000 (Figure 3, Supplementary Table S2).  
284 After adjustment for covariates, the increased risks of suicide after self-inflicted and  
285 after drug/alcohol-related index injury (vs. accident-related injury) were similar to the  
286 risks of drug/alcohol-related death. For example, among boys discharged after self-  
287 inflicted injury compared with after accident-related injury, the adjusted SHR was 6.20  
288 [5.27, 7.30] for suicide and 5.91 [4.96, 7.03], for drug/alcohol-related death) (Table  
289 3). These adjusted SHRs were similar whether the death was related to suicide but not  
290 drugs/alcohol, drugs/alcohol but not suicide, or both causes (Supplementary Table S3;  
291 i.e. comparing between columns).

292

### 293 *Socio-demographic and clinical covariates*

294 Boys aged 18-19 years who were discharged after self-inflicted injury or drug/alcohol-  
295 related injury had the highest risks of death due to any cause (ten-year risks: 30.4 per  
296 1,000, or 1 per 33, after self-inflicted injury, 25.1 per 1,000, or 1 per 40, after  
297 drug/alcohol related injury; Supplementary Table S2). These risks were substantially  
298 higher than after accident-related injury (8.8 per 1,000) or for the general population of  
299 18-19 year old boys (8.9 per 1,000). These risks were driven by high risks of suicide  
300 and drug/alcohol-related death.

301

302 Adolescents aged 18-19 years had twice the mortality risk compared with 10-15 year  
303 olds, due to increased risks of suicide and drug/alcohol-related deaths among older

304 girls and boys, and increased risks of accidental deaths among older boys (Table 2;  
305 Table 3). Low SES (i.e. most deprived) was associated with increased risks of total  
306 and cause-specific mortality, apart from suicide in boys, in whom low SES was  
307 associated with a decreased risk of suicide.

308 Adolescents with a chronic condition (vs. none) had a 3- to 4-fold increased risk of  
309 death due to any cause, and a 10- to 12-fold increased risk of death due to causes other  
310 than adversity or accidents, regardless of the type of index injury (Table 2). For  
311 example, for 18-19 year old boys discharged after an adversity-related index injury, the  
312 ten-year risk of death due to any cause was 37.5 per 1,000 given a chronic condition  
313 and 14.8 per 1,000 given none (data not shown). For 18-19 year old boys discharged  
314 after accident-related injury, these risks were 17.5 and 8.8 per 1,000 respectively.

315

## 316 **Discussion**

317 This retrospective cohort study determined cause-specific risks of death up to ten years  
318 after adolescents were discharged from the NHS in England following injury related to  
319 'adversity' (self-harm, drug/alcohol misuse, violence) or accidents. Within ten years  
320 after discharge following adversity-related injury 1 per 137 girls and 1 per 63 boys had  
321 died. We found that suicide, drug/alcohol-related deaths, and a small number of  
322 homicides accounted for 61% of all deaths ten years after adversity-related injury, but  
323 only 35% of deaths after accident-related injury. Second, we showed that risks of  
324 suicide were all increased following self-inflicted injury, drug/alcohol-related injury,  
325 and following violent injury. These risks were highest for 18-19 year old boys. Third,  
326 the risks of suicide were similar to those of drug/alcohol-related deaths regardless of  
327 whether the adversity-related index injury was self-inflicted, drug/alcohol-related, or  
328 violent. Fourth, adolescents with an underlying chronic condition at the index injury  
329 admission (10-15%)<sup>5</sup> were at increased risk of all causes of death, independently of the  
330 type of adversity or accident-related injury or age at admission.

331

332 **Strengths and limitations**

333 The main strength of our study is the use of linked NHS emergency admissions and  
334 mortality data, which included all injury admissions in England linked to subsequent  
335 mortality records in England and Wales over 15 years.<sup>13</sup> The population-based cohort  
336 of nearly one million 10-19 year olds allowed us to compare risks of cause-specific  
337 mortality between different types of index injury admissions. We used time-to-event  
338 statistical methods to estimate risks whilst taking into account censoring of outcomes  
339 and competing risks of different causes of death.<sup>16</sup> Although we combined index injury  
340 admissions across a 15-year period, our conclusions were not sensitive to calendar  
341 period (e.g. boys in 1997, adjusted SHR of suicide for adversity-related vs. accident-  
342 related injury [95% CI]: 2.6 [1.7, 3.9]; corresponding SHR for boys in 2012: 3.2 [2.2,  
343 4.7]; data not shown).

344

345 One limitation is that ICD codes used to define adversity-related injury and deaths tend  
346 to have high specificity but low sensitivity.<sup>20-22</sup> The potential misclassification of  
347 exposure (i.e. self-inflicted, drug/alcohol-related, or violent injury, misclassified as  
348 accident-related injury) and outcomes (i.e. suicide, drug/alcohol-related deaths, or  
349 homicides, misclassified as accidental or other deaths) may induce bias in the estimates  
350 of their associations, which is likely to under-estimate the increased risks of suicide and  
351 drug/alcohol-related deaths after adversity-related injury relative to after accident-  
352 related injury. To minimise this potential bias we included codes for undetermined  
353 intent and adjourned inquests in the definitions of suicide and homicide, respectively.  
354 The prevalence of chronic conditions recorded by codes at the index injury admission  
355 or at hospitalisation during the previous year may be under-ascertained, particularly to  
356 the presence of chronic mental health conditions.

357

358 A further limitation is potential linkage error between HES and ONS mortality data.  
359 One of the few studies that have investigated linkage errors in HES data showed high  
360 missed match rates (4.1%) that were higher for males and ethnic minorities.<sup>22</sup> Linkage  
361 error between HES and ONS mortality data would favour underestimation of mortality  
362 rates.<sup>22</sup> Lastly, the study was likely under-powered to detect differences in the risks of  
363 homicide between index injury groups.

364

### 365 **Comparison with other studies**

366 Our main finding of similar increases in risks of suicide death following self-inflicted  
367 injury and following drug/alcohol related injury has not been previously reported. We  
368 report lower ten-year risks of death after admission for self-inflicted injury (girls: 7.7  
369 per 1,000, boys: 24.1 per 1,000; Supplementary Table S2) than the 20-year mortality  
370 rates after presentation with self-inflicted injury reported by Hawton *et al* (girls: 17 per  
371 1,000, boys: 50 per 1,000).<sup>9</sup> These differences may be because Hawton *et al* studied  
372 young people aged 15-25 years and determined mortality after 20 years of follow up.  
373 In Hawton *et al*'s study, 60.0% of deaths in girls and 45.6% of those in boys were from  
374 suicide (including deaths of undetermined intent and drug/alcohol-related suicides),<sup>9</sup>  
375 compared with 39.8% and 43.2% in our study (Table 1).

376

### 377 **Implications for practice, policy, and research**

378 Our findings suggest that specialist psychosocial assessment by a child and adolescent  
379 mental health professional, which is part of recommended standard practice for self-  
380 inflicted injury in the UK, should be considered for adolescents presenting with  
381 drug/alcohol-related or violent injury. The need for a consistent approach targeting all  
382 three adversity-related injury groups is supported by previous evidence of their  
383 common underlying psychosocial problems, the overlap among the same admitted  
384 adolescents,<sup>4</sup> and similar patterns of risky behaviours into young adulthood, particularly  
385 relating to self-harm and drug/alcohol use.<sup>24-26</sup> Clinical and public health strategies need  
386 to be extended to include reducing risks of death related to drugs/alcohol, which are  
387 just as high as risks of suicide death. If it were possible to completely eradicate the  
388 excess mortality risk associated with adversity-related injury among hospitalised  
389 adolescents, we could have expected 857 fewer suicide and drug/alcohol-related deaths  
390 in our cohort (girls: 392 [219 drug/alcohol-related deaths], boys: 683 [394]; based on  
391 the estimated relative risks in Table 2). Among 16-19 year olds, the burden of suicides  
392 in the decade after adversity-related injury represented approximately 10-25% of  
393 suicides expected in the general population during the same follow-up (based on ten-  
394 year risks in Supplementary Table S2, and ~3-4% of the general population of 16-19  
395 year olds admitted with adversity-related injury).<sup>4</sup>

396

397 Findings from the current study are likely to be generalisable to other UK countries,  
398 where rates of hospitalisations during adolescence for adversity-related injury and  
399 mortality through intentional injuries are similar.<sup>27, 15</sup> Generalisation to non-UK settings  
400 requires further research.

401

402 There is a need for investment in interventions for reducing harm after all types of  
403 adversity-related injury, whether self-inflicted, drug/alcohol-related, or violent. Risks  
404 of death are substantially increased in adolescents admitted with chronic conditions,  
405 and appropriate effective interventions may differ for this sub-group. There is a lack  
406 of evidence to determine how public health bodies and services can reduce or  
407 ameliorate risks of long-term harm after adversity-related injury in adolescence.<sup>28-30</sup>  
408 Interventions need to be developed and evaluated in randomised controlled trials to  
409 enable services to respond effectively and appropriately.

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415

416 **Contributors**

417 AH, RG, and LL conceived and designed the study. AH analysed the data and drafted  
418 the first version of the article. AH, RG, DC, and LL interpreted the data, revised the  
419 article critically for important intellectual content, and approved the final version to be  
420 published.

421

422 **Conflicts of interest**

423 None to declare.

424

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432 and the Biomedical Research Centre at the University College London Great Ormond  
433 Street Institute of Child Health.

434

435 **Data sources**

436 Hospital Episode Statistics data can be accessed by researchers applying to NHS

437 Digital (previously the Health and Social Care Information Centre for England).

438 Copyright 2016, reused with the permission of NHS Digital. All rights reserved.

439 Bespoke extracts and tabulations of mortality data for England and Wales are

440 available to order from the ONS (subject to legal frameworks, disclosure control,

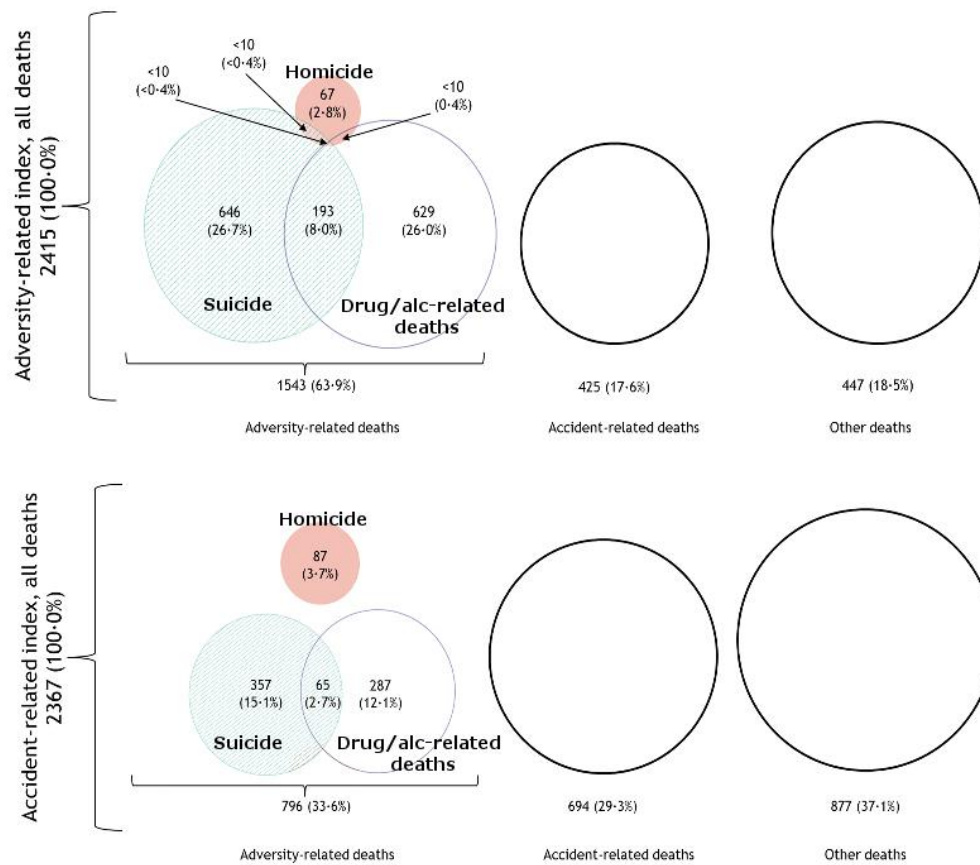
441 resources and agreement of costs, where appropriate). Such enquiries should be made

442 to the mortality team at [mortality@ons.gsi.gov.uk](mailto:mortality@ons.gsi.gov.uk).

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493 [aths/adhocs/006513deathsfromspecificgroupedcausesengland1997to2012](https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/deaths/adhocs/006513deathsfromspecificgroupedcausesengland1997to2012) (accessed  
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529

530

**Figure 1:** Numbers and proportions of deaths by reported cause

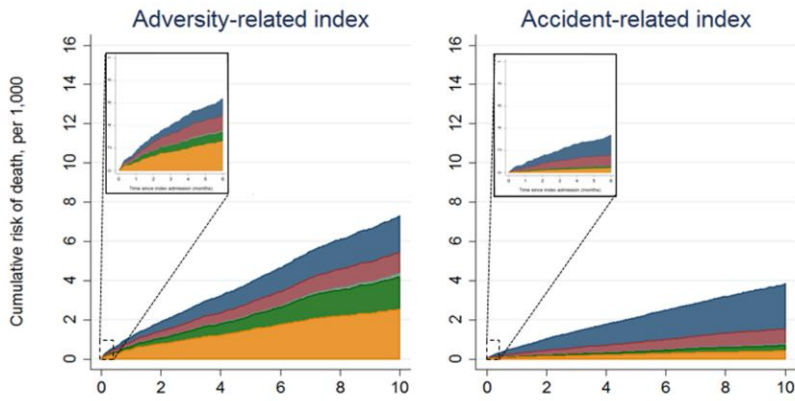
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Circles represent proportions and are drawn to scale within each figure (i.e. type of injury). Accidental death: codes for accidents and no codes for adversity in death certificate; Other death: no codes for accidents or adversity in death certificate.

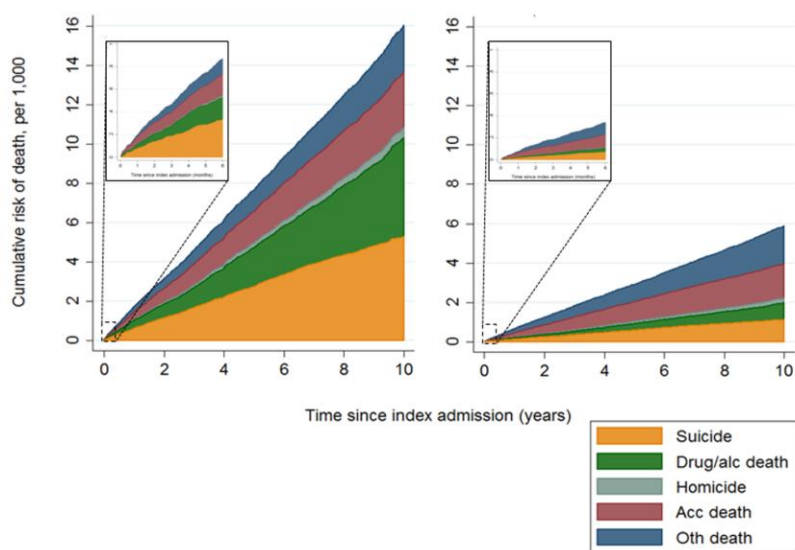
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Girls



Boys

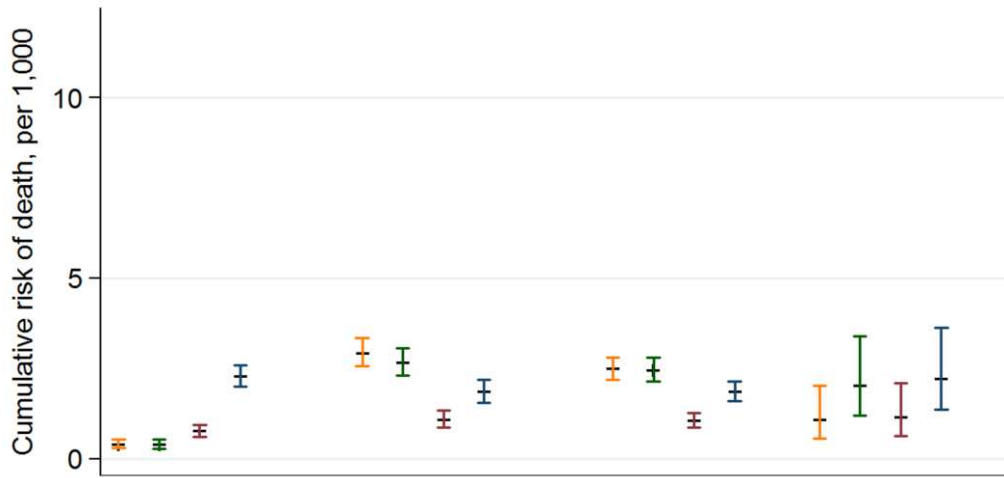


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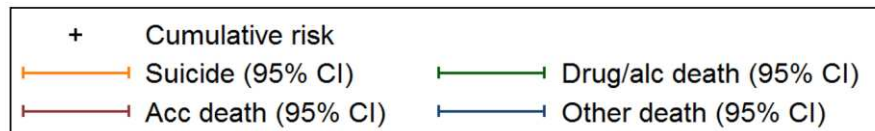
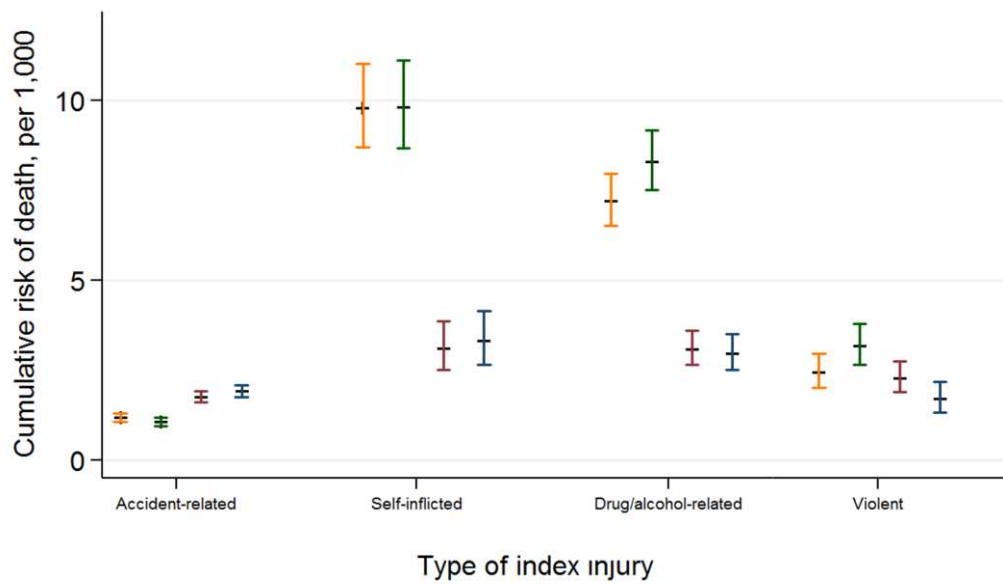
**Figure 2:** Cumulative risk of cause-specific death over time, by sex and adversity-related or accident-related index injury at admission

Drug/alc = Drug/alcohol-related; Acc = Accidental; Oth = Other; 'Suicide' includes all suicides, whether homicide or drug/alcohol-related death were also implicated or not; Drug/alc death includes only drug/alcohol-related deaths where suicide was not also implicated; 'Homicide' includes only where suicide or drug/alcohol-related death was not also implicated. Here cumulative risks are cumulative incidence functions.

## Girls



## Boys



541

542 **Figure 3:** Ten-year cumulative risk of cause-specific deaths, by sex and type of index injury

543 Drug/alc = Drug/alcohol-related; Acc = Accidental; Oth = Other;

544 **Table 1:** Number and proportion of cause-specific deaths within ten years after index injury admission, by sex and type of index injury

Type of injury at index admission	Numbers of deaths by cause (row %)						
	Discharged	Total deaths	Adversity-related*	Suicide	DA	Accidental	Other
<b>Girls</b>	348 388	1 312 (100·0)	603 (46·0)	361 (27·5)	319 (24·3)	228 (17·4)	481 (36·7)
Accident-related	166 462	439 (100·0)	85 (19·4)	47 (10·7)	41 (9·3)	94 (21·4)	260 (59·2)
Adversity-related	181 926	873 (100·0)	518 (59·3)	314 (36·0)	278 (31·8)	134 (15·3)	221 (25·3)
Self-inflicted	131 739	651 (100·0)	408 (62·7)	259 (39·8)	210 (32·3)	93 (14·3)	150 (23·0)
DA	163 888	776 (100·0)	464 (59·8)	283 (36·5)	250 (32·2)	117 (15·1)	195 (25·1)
Violent	13 262	54 (100·0)	25 (46·3)	10 (18·5)	16 (29·6)	11 (20·4)	18 (33·3)
<b>Boys</b>	634 439	3 470 (100·0)	1 736 (50·0)	903 (26·0)	861 (24·8)	891 (25·7)	843 (24·3)
Accident-related	483 356	1 928 (100·0)	711 (36·9)	375 (19·5)	311 (16·1)	600 (31·1)	617 (32·0)
Adversity-related	151 083	1 542 (100·0)	1 025 (66·5)	528 (34·2)	550 (35·7)	291 (18·9)	226 (14·7)
Self-inflicted	44 621	704 (100·0)	526 (74·7)	304 (43·2)	276 (39·2)	92 (13·1)	86 (12·2)
DA	85 421	1 112 (100·0)	775 (69·5)	418 (37·6)	424 (38·1)	183 (16·5)	154 (13·8)
Violent	70 594	460 (100·0)	268 (58·0)	120 (26·1)	135 (29·2)	122 (26·4)	70 (15·2)

545 DA = Drug/alcohol-related

546 \*Suicides, drug/alcohol-related deaths, and homicides. These deaths were not mutually exclusive. Numbers and proportions are not reported for homicides due to small counts.

547  
548

**Table 2:** Relative risk of cause-specific death within 10 years after adversity-related index injury (vs. accident-related injury), adjusted for age-group, socio-economic status, and chronic condition status, by sex (multivariable analyses)

Characteristic at index injury admission	Cause of death, Adjusted sub-hazard ratio (95% Confidence Interval)									
	All deaths		Suicide		DA death		Accidental death		Other death	
Girls										
<b>Adversity- (vs. accident-related) injury</b>	<b>1.51</b>	<b>(1.34 to 1.71)</b>	<b>4.54</b>	<b>(3.25 to 6.36)</b>	<b>4.71</b>	<b>(3.28 to 6.76)</b>	<b>1.21</b>	<b>(0.90 to 1.63)</b>	<b>0.64</b>	<b>(0.53 to 0.77)</b>
Age-group (vs. 10-15y)										
16-17y	1.40	(1.21 to 1.61)	2.30	(1.63 to 3.25)	1.88	(1.35 to 2.63)	1.13	(0.80 to 1.58)	1.08	(0.87 to 1.35)
18-19y	2.10	(1.82 to 2.42)	4.34	(3.10 to 6.07)	2.76	(1.98 to 3.86)	1.60	(1.13 to 2.26)	1.44	(1.16 to 1.79)
Socio-economic status (vs. least deprived)										
Second least	1.17	(0.89 to 1.54)	0.81	(0.55 to 1.18)	1.13	(0.70 to 1.84)	1.28	(0.80 to 2.04)	1.15	(0.80 to 1.65)
Middle	1.19	(0.92 to 1.56)	0.69	(0.47 to 1.01)	1.29	(0.82 to 2.04)	1.12	(0.70 to 1.79)	1.28	(0.90 to 1.81)
Second most	1.53	(1.20 to 1.95)	0.89	(0.64 to 1.25)	1.44	(0.94 to 2.22)	0.97	(0.61 to 1.55)	1.48	(1.07 to 2.06)
Most deprived	1.57	(1.24 to 1.98)	0.78	(0.57 to 1.08)	1.64	(1.09 to 2.47)	1.02	(0.67 to 1.57)	1.59	(1.17 to 2.16)
Chronic condition (vs. none)	3.77	(3.38 to 4.20)	1.91	(1.54 to 2.36)	2.53	(2.02 to 3.16)	2.35	(1.80 to 3.07)	10.14	(8.29 to 12.41)
Boys										
<b>Adversity- (vs. accident-related) injury</b>	<b>1.94</b>	<b>(1.80 to 2.08)</b>	<b>3.15</b>	<b>(2.73 to 3.63)</b>	<b>3.53</b>	<b>(3.04 to 4.09)</b>	<b>1.26</b>	<b>(1.09 to 1.47)</b>	<b>0.99</b>	<b>(0.84 to 1.17)</b>
Age-group (vs. 10-15y)										
16-17y	1.73	(1.58 to 1.89)	2.70	(2.21 to 3.30)	3.05	(2.41 to 3.84)	1.60	(1.35 to 1.89)	1.14	(0.97 to 1.35)
18-19y	2.23	(2.04 to 2.44)	3.48	(2.83 to 4.26)	5.04	(4.03 to 6.31)	1.91	(1.61 to 2.27)	1.22	(1.02 to 1.45)
Socio-economic status (vs. least deprived)										
Second least	1.24	(1.08 to 1.42)	1.17	(0.89 to 1.54)	1.19	(0.86 to 1.63)	1.62	(1.25 to 2.09)	1.14	(0.88 to 1.47)
Middle	1.28	(1.13 to 1.46)	1.19	(0.92 to 1.56)	1.66	(1.24 to 2.22)	1.62	(1.25 to 2.07)	1.02	(0.79 to 1.32)
Second most	1.42	(1.26 to 1.61)	1.53	(1.20 to 1.95)	1.86	(1.41 to 2.45)	1.29	(1.00 to 1.66)	1.33	(1.05 to 1.68)
Most deprived	1.63	(1.45 to 1.83)	1.57	(1.24 to 1.98)	2.17	(1.66 to 2.82)	1.72	(1.36 to 2.18)	1.26	(1.01 to 1.58)

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Chronic condition (vs. none)	2.63	(2.45 to 2.82)	1.26	(1.08 to 1.47)	1.81	(1.56 to 2.09)	1.62	(1.39 to 1.88)	11.72	(10.09 to 13.61)
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Each column (by sex) represents a separate Fine & Gray's competing risks model. Adversity (vs. accident-related) injury, age-group, socio-economic status, and chronic condition status were entered as covariates simultaneously, per model.

DA = Drug/alcohol-related

552 **Table 3:** Relative risk of cause-specific death within 10 years after each type of adversity-related index injury (vs. accident-related injury), adjusted for age-  
 553 group, socio-economic status, and chronic conditions, by sex (multivariable analyses)

Type of adversity-related index injury (vs. accident-related)	Cause of death, Sub-hazard ratio (95% Confidence Interval)									
	All deaths		Suicide		DA death		Accidental death		Other death	
Girls										
Self-inflicted	1.52	(1.33 to 1.73)	5.11	(3.61 to 7.23)	5.14	(3.50 to 7.55)	1.17	(0.85 to 1.63)	0.59	(0.48 to 0.72)
Drug/alcohol-related	1.45	(1.28 to 1.64)	4.55	(3.23 to 6.39)	4.52	(3.14 to 6.51)	1.20	(0.88 to 1.64)	0.62	(0.51 to 0.75)
Violent	1.24	(0.93 to 1.66)	1.48	(0.73 to 2.98)	2.75	(1.47 to 5.17)	1.34	(0.71 to 2.55)	0.76	(0.46 to 1.23)
Boys										
Self-inflicted	2.83	(2.58 to 3.10)	6.20	(5.27 to 7.30)	5.91	(4.96 to 7.03)	1.31	(1.05 to 1.64)	1.07	(0.84 to 1.35)
Drug/alcohol-related	2.46	(2.27 to 2.66)	4.51	(3.89 to 5.24)	4.91	(4.24 to 5.73)	1.40	(1.18 to 1.67)	1.11	(0.92 to 1.34)
Violent	1.25	(1.13 to 1.39)	1.43	(1.15 to 1.78)	1.78	(1.44 to 2.19)	1.10	(0.90 to 1.35)	0.76	(0.59 to 0.97)

554 Each cell represents a separate Fine & Gray's competing risks model, where the corresponding type of adversity-related index injury (vs. accident-related injury), age-group, socio-economic status, and chronic  
 555 condition status were entered as covariates simultaneously, per model. Sub-hazard ratios for age-group, socio-economic status, and chronic condition status, for each of the thirty models are not presented here but  
 556 were very similar to those presented in Table 2 (conditional on sex and cause of death).  
 557

558 DA = Drug/alcohol-related  
 559  
 560

561 **Panel: Research in context**

562 **Systematic review**

563 We searched for studies (including reviews) of cause-specific death after hospital  
564 attendance for any adversity-related injury published from Jan 1995-May 2016. We  
565 searched Google Scholar, Scopus, PubMed, and Web of Science using terms  
566 ‘‘adolescents’’, ‘‘injury’’, ‘‘hospital’’, ‘‘self-harm’’, ‘‘drug or alcohol use’’,  
567 ‘‘violence’’, and ‘‘mortality’’. We found six studies (seven articles), but no relevant  
568 systematic review. Five (European) studies reported risks of death due to suicide, and  
569 some also reported risks of deaths due to drug/alcohol use (n=2), homicide (n=2),  
570 undetermined/accidental causes (n=3), and chronic conditions (n=3), in up to 15 years  
571 after adolescents presented to hospital with self-inflicted injury. One (US) study  
572 reported frequencies of deaths from homicide, drug overdose, and traffic accidents in  
573 the two years after discharge following violent injury in 559 adolescents. We did not  
574 identify any studies that reported rates of cause-specific death following hospital  
575 presentation or admission for drug/alcohol-related injury, or compared risks of cause-  
576 specific deaths after discharge following any adversity-related injury with those  
577 following accident-related injury.

578 **Interpretation**

579 Our study adds new evidence on the risks of cause-specific death up to ten years after  
580 discharge following adversity-related and accident-related injury among young  
581 people. Our finding of elevated risks of suicide following all types of adversity-  
582 related injury (versus accident-related injury) suggests that clinical and public health  
583 strategies need to be extended to reduce harm after all types of adversity-related  
584 injury, whether self-inflicted, drug/alcohol-related or violent. Similar risks of suicide  
585 and drug/alcohol-related deaths following discharge from any type of index injury  
586 found in our study also stress the need of preventive strategies, both within and  
587 outside the healthcare sector, to reduce public health burden of suicide and  
588 drug/alcohol-related deaths.

589 **Causes of death up to ten years after hospitalisation for self-**  
590 **inflicted, drug/alcohol-related, or violent injury during adolescence:**  
591 **a nationwide cohort study**

592

593 Annie Herbert, Ruth Gilbert, David Cottrell, Leah Li

594

595

596 **Supplementary material**

597 **Table S1:** ICD-9 and ICD-10 codes for related causes of death

598

599 **Figure S1:** Formation of sub-groups of adolescents with adversity-related and accident-  
600 related index injury

601

602 **Table S2:** Observed ten-year cumulative risks (95% CI) of death after discharge from index  
603 injury admission, by age-group, type of index injury for each cause of death for girls

604

605 **Table S3:** Relative risks of suicide and drug/alcohol-related deaths within 10 years after self-  
606 inflicted or drug/alcohol-related index injury (vs. accident-related injury), adjusted for age-  
607 group, socio-economic status, and chronic conditions, by sex (multivariable analyses)

608 **Table S1:** ICD-9 and ICD-10 codes for related causes of death

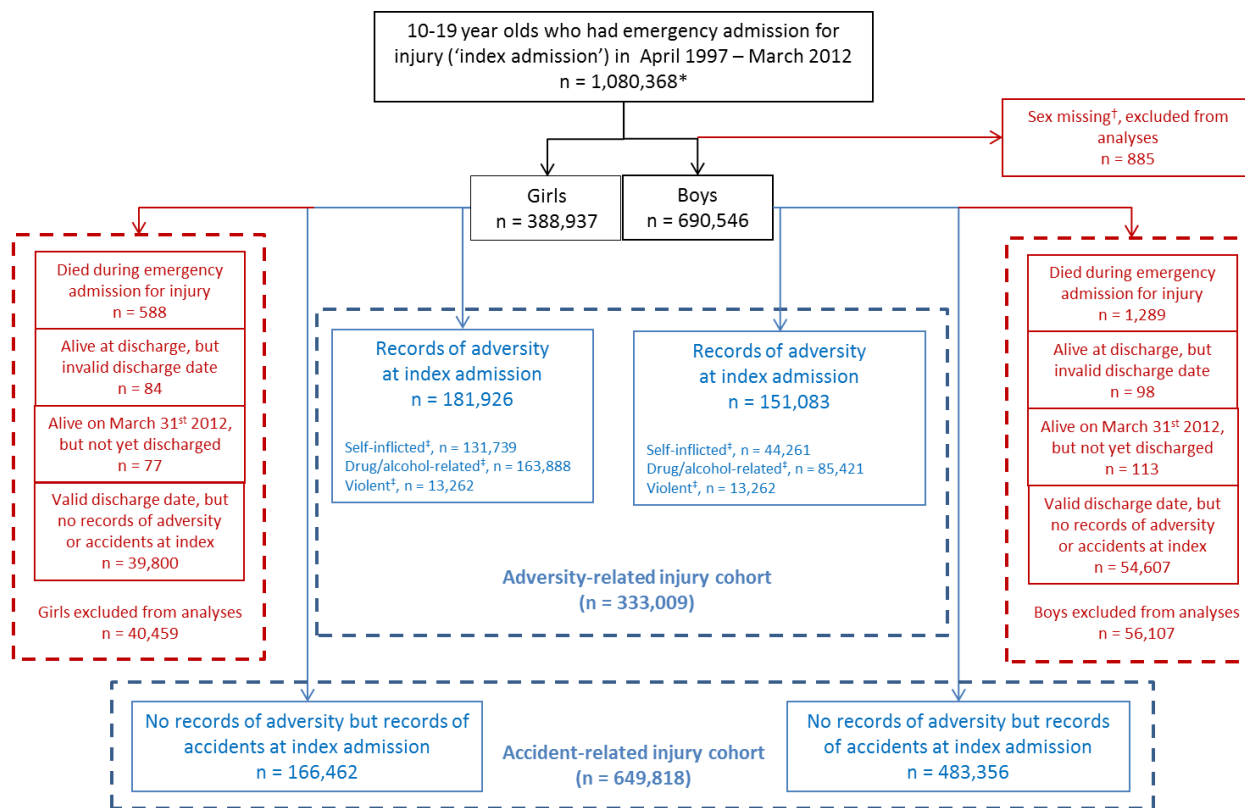
Clusters	CODES
ICD version	
Descriptions	
<b>Suicide</b>	
ICD-9:	
Suicide and self-inflicted injury	E950 - E959
Injury undetermined whether accidentally or purposely inflicted	E980 - E989
ICD-10:	
Intentional self-poisoning by and exposure to...	
...drugs	X60 - X63
...other and unspecified drugs, medicaments and biological substances	X64
...alcohol	X65
...organic solvents and halogenated hydrocarbons and their vapours	X66
...other gases and vapours	X67
...pesticides	X68
...other and unspecified chemicals and noxious substances	X69
Intentional self-harm by...	
...hanging, strangulation and suffocation	X70
...drowning and submersion	X71
...firearm discharge	X72 - X74
...explosive material	X75
...smoke, fire and flames, or steam, hot vapours and hot objects	X76 - X77
...sharp/blunt objects	X78 - X79
...jumping from a high place	X80
...jumping or lying before a moving object, or crashing a motor vehicle	X81 - 82
...other specified means	X83
...unspecified means	X84
Undetermined intent	
Poisoning, undetermined intent	Y1
Hanging, strangulation and suffocation, undetermined intent	Y20
Drowning and submersion, undetermined intent	Y21
Firearm-related, undetermined intent	Y22 - Y24
Contact with explosive material, steam, hot vapours, or hot, sharp, or blunt objects, undetermined intent	Y25, Y27 - Y29
Exposure to smoke, fire and flames, undetermined intent	Y26
Falling, undetermined intent	Y30 - Y31
Crashing of motor vehicle, undetermined intent	Y32
Other or unspecified, undetermined intent	Y33 - Y34 (excluding Y33-9)
<b>Drug/alcohol-related death</b>	
ICD-10	
Drugs, medicaments and biological substances (illicit drugs)	
Mental and behavioural disorders due to psychoactive substance use	F11 - F14, F16, F19
Finding of drugs not normally found in blood	R78-1 - R78-5
Poisoning by drugs, medicaments and biological substances	T36-T50 (excluding T50-6)
Drug rehabilitation	Z50-3
Drug abuse counselling and surveillance	Z71-5
Drug use	Z72-2
Environmental/ Domestic substances	
Mental and behavioural disorders due to use of volatile solvents	F18
Accidental poisoning by and exposure to noxious substances	X40 - X44, X46 - X49

Codes mentioning both alcohol and drugs	
Special epileptic syndromes - (related to alcohol, drugs, etc.)	G40.5
Blood-alcohol and blood-drug test	Z04.0
Alcohol	
Alcohol-induced pseudo-Cushing's syndrome	E24.4
Mental and behavioural disorders due to use of alcohol	F10
Degeneration of nervous system due to alcohol	G31.2
Alcoholic polyneuropathy	G62.1
Alcoholic myopathy	G72.1
Alcoholic cardiomyopathy	I42.1
Alcoholic gastritis	K29.2
Alcoholic liver disease	K70
Alcohol-induced acute pancreatitis	K85.2
Alcohol-induced chronic pancreatitis	K86.0
Maternal care for (suspected) damage to fetus from alcohol	O35.4
Finding of alcohol in blood	R78.0
Poisoning: antidotes and chelating agents, not elsewhere classified	T50.6
Toxic effect of alcohol	T51
Accidental poisoning by exposure to alcohol	X45
Evidence of alcohol involvement determined by blood alcohol level	Y90
Evidence of alcohol involvement determined by level of intoxication	Y91
Alcohol rehabilitation	Z50.2
Alcohol abuse counselling and surveillance	Z71.4
Alcohol use	Z72.1
<b>Homicide</b>	
ICD-9:	
<b>Homicide and injury purposely inflicted by other persons</b>	E960 - E969
ICD-10:	
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 – X99, Y01 - Y09
Adjourned inquest	U50.9
<b>Accidental</b>	
ICD-9:	
Accidents	E800 - E949
Legal intervention	E970 - E978
Injury resulting from operations of war	E990 - E999
ICD-10:	
Transport accidents	V01 - V99
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
Overexertion, travel and privation	X50 - X57
Accidental exposure to other and unspecified factors	X58 - X59

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611 **Figure S1: Formation of sub-groups of adolescents with adversity-related and accident-related index injury**

612 This figure has been reproduced and modified from Herbert *et al*, 2015.<sup>5</sup>  
 613 \* 49,784 girls and 80,205 boys had more than one emergency admission for injury between 10 and 19 years. For each of these adolescents, one emergency admission for injury was randomly selected as the index  
 614 emergency admission for injury.  
 615 † Not possible to impute any missing values at 0–30 years old (process for imputing values described in Herbert *et al*, 2015).<sup>5</sup>  
 616 ‡ Self-inflicted, drug/alcohol-related, and violent injury are not mutually exclusive.

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**Table S2:** Observed ten-year cumulative risks (95% CI) of death after discharge from index injury admission, by age-group, type of index injury for each cause of death for girls

Index injury	N	Total deaths	Adversity-related death*	Suicide	DA death	Accidental death	Other death
<b>Girls: 10-15 years</b>	151 141	3.5 (3.2, 3.9)	1.0 (0.8, 1.2)	0.5 (0.4, 0.6)	0.6 (0.5, 0.8)	0.7 (0.6, 0.9)	1.8 (1.5, 2.0)
Accident-related	103 215	2.9 (2.5, 3.3)	0.3 (0.2, 0.4)	0.1 (0.0, 0.2)	0.1 (0.1, 0.2)	0.6 (0.4, 0.8)	2.1 (1.8, 2.4)
Adversity-related	47 926	4.8 (4.1, 5.7)	2.7 (2.1, 3.4)	1.3 (1.0, 1.8)	1.7 (1.3, 2.3)	1.1 (0.8, 1.5)	1.0 (0.8, 1.4)
Self-inflicted	32 309	5.1 (4.2, 6.3)	3.2 (2.5, 4.2)	1.6 (1.1, 2.3)	2.2 (1.6, 3.1)	1.2 (0.8, 1.8)	0.7 (0.4, 1.2)
Drug/alcohol-related	41 973	4.7 (4.0, 5.6)	2.6 (2.0, 3.3)	1.4 (1.0, 1.9)	1.6 (1.1, 2.2)	1.2 (0.9, 1.7)	0.9 (0.6, 1.3)
Violent	3 923	4.3 (2.4, 7.6)	2.2 (0.9, 5.3)	0.0 (0.0, 0.0)	1.6 (0.6, 4.3)	0.6 (0.2, 2.4)	1.5 (0.6, 3.6)
General population <sup>†</sup>		2.7		0.2 <sup>‡</sup>	0.2	0.5	
<b>Girls: 16-17 years</b>	121 229	6.2 (5.6, 6.8)	3.2 (2.8, 3.7)	1.8 (1.5, 2.1)	1.9 (1.6, 2.3)	0.9 (0.7, 1.1)	2.0 (1.7, 2.4)
Accident-related	36 624	5.0 (4.2, 6.1)	1.5 (1.0, 2.1)	0.8 (0.5, 1.4)	0.7 (0.4, 1.3)	0.8 (0.5, 1.3)	2.8 (2.2, 3.6)
Adversity-related	84 605	6.7 (6.0, 7.5)	4.1 (3.5, 4.7)	2.2 (1.8, 2.7)	2.4 (2.0, 2.9)	0.9 (0.7, 1.2)	1.7 (1.4, 2.2)
Self-inflicted	63 520	6.8 (6.0, 7.8)	4.3 (3.7, 5.1)	2.5 (2.1, 3.1)	2.4 (1.9, 3.0)	0.9 (0.7, 1.3)	1.6 (1.2, 2.1)
Drug/alcohol-related	77 164	6.4 (5.7, 7.2)	4.0 (3.4, 4.6)	2.1 (1.7, 2.6)	2.4 (2.0, 3.0)	0.8 (0.6, 1.1)	1.6 (1.3, 2.1)
Violent	5 269	8.1 (5.4, 12.0)	2.8 (1.5, 5.3)	1.2 (0.5, 3.3)	2.0 (1.0, 4.3)	1.5 (0.6, 3.7)	3.8 (2.0, 7.0)
General population <sup>†</sup>		3.5		0.3	0.4	0.6	
<b>Girls: 18-19 years</b>	76 018	9.1 (8.3, 10.1)	4.9 (4.3, 5.6)	3.1 (2.6, 3.6)	2.5 (2.0, 3.0)	1.3 (1.0, 1.7)	3.0 (2.5, 3.5)
Accident-related	26 623	5.7 (4.7, 6.9)	1.8 (1.3, 2.6)	1.0 (0.7, 1.6)	1.0 (0.6, 1.6)	1.4 (0.9, 2.1)	2.5 (1.8, 3.4)
Adversity-related	49 395	11.1 (10.0, 12.4)	6.6 (5.7, 7.6)	4.2 (3.5, 5.0)	3.3 (2.7, 4.1)	1.3 (0.9, 1.8)	3.2 (2.6, 4.0)
Self-inflicted	35 910	11.9 (10.5, 13.5)	7.3 (6.2, 8.6)	4.8 (4.0, 5.9)	3.5 (2.8, 4.4)	1.3 (0.8, 1.9)	3.4 (2.7, 4.3)
Drug/alcohol-related	44 751	11.2 (10.0, 12.6)	6.7 (5.7, 7.7)	4.3 (3.6, 5.2)	3.3 (2.7, 4.1)	1.2 (0.9, 1.8)	3.3 (2.7, 4.1)
Violent	4 070	6.1 (3.6, 10.5)	4.0 (2.0, 7.9)	1.9 (0.8, 4.3)	2.4 (0.9, 6.2)	1.2 (0.4, 3.2)	1.0 (0.2, 4.3)
General population <sup>†</sup>		3.5		0.4	0.5	0.5	
<b>Girls: All</b>	348 388	5.6 (5.3, 5.9)	2.6 (2.4, 2.8)	1.5 (1.3, 1.6)	1.4 (1.3, 1.6)	0.9 (0.8, 1.1)	2.1 (1.9, 2.3)
Accident-related	166 462	3.8 (3.4, 4.2)	0.8 (0.6, 0.9)	0.4 (0.3, 0.5)	0.4 (0.3, 0.5)	0.8 (0.6, 0.9)	2.3 (2.0, 2.6)
Adversity-related	181 926	7.3 (6.8, 7.9)	4.4 (4.0, 4.8)	2.5 (2.2, 2.8)	2.5 (2.2, 2.8)	1.1 (0.9, 1.3)	1.9 (1.7, 2.2)

Self-inflicted	131 739	7.8 (7.2, 8.4)	4.8 (4.4, 5.4)	2.9 (2.6, 3.3)	2.7 (2.3, 3.1)	1.1 (0.9, 1.3)	1.8 (1.6, 2.2)
Drug/alcohol-related	163 888	7.2 (6.7, 7.8)	4.3 (3.9, 4.7)	2.5 (2.2, 2.8)	2.4 (2.1, 2.8)	1.1 (0.9, 1.3)	1.9 (1.6, 2.2)
Violent	132 62	6.4 (4.8, 8.4)	3.0 (2.0, 4.6)	1.1 (0.6, 2.0)	2.0 (1.2, 3.4)	1.1 (0.6, 2.1)	2.2 (1.4, 3.6)
General population <sup>†</sup>		3.0		0.3 <sup>‡</sup>	0.3	0.5	

Data presented as risk per 1,000 (95% Confidence Interval), unless otherwise stated.

\*Suicides, homicides and drug/alcohol-related deaths. These deaths were not mutually exclusive. Risks are not reported for homicides due to small counts.

<sup>†</sup>Derived from publicly available life-tables for England and Wales for 1997-2012 (total deaths: Excel sheet 'nlteng1214reg\_tcm77-414444.xls',

<http://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/lifeexpectancies/datasets/nationallifetablesenglandreferencetables>; suicides: Excel sheet 'suicidereferencetablestcm77432201-1.xls' (Table 10), [http://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/deaths/datasets/suicidesintheunitedkingdomreferencetables; drug/alcohol-related deaths and accidental deaths](http://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/deaths/datasets/suicidesintheunitedkingdomreferencetables;drug/alcohol-related%20deaths%20and%20accidental%20deaths). Ten-year risks derived as per Herbert *et al*, Plos Medicine 2015 (Supplementary Table S2).

<sup>‡</sup>Ten-year risks of suicide among 10-15 year olds and 10-19 year olds in the general population are likely to be under-estimated, since rates were not provided for 10-5 year olds in years where there were fewer than 3 death registrations of this type.

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**Table S2 (continued):** Observed ten-year cumulative risks (95% CI) of death after discharge from index injury admission, by age-group, type of index injury for each cause of death for boys

Index injury	N	Total deaths	Adversity-related death*	Suicide	DA death	Accidental death	Other death
<b>Boys: 10-15 years</b>	284 163	4.9 (4.6, 5.3)	1.6 (1.4, 1.8)	0.8 (0.7, 1.0)	0.6 (0.5, 0.8)	1.5 (1.3, 1.7)	1.9 (1.7, 2.1)
Accident-related	259 862	4.5 (4.2, 4.9)	1.3 (1.2, 1.6)	0.7 (0.6, 0.8)	0.5 (0.4, 0.7)	1.4 (1.2, 1.6)	1.8 (1.6, 2.0)
Adversity-related	24 301	9.3 (7.8, 11.0)	4.5 (3.5, 5.7)	2.3 (1.6, 3.2)	1.9 (1.3, 2.7)	2.4 (1.7, 3.3)	2.5 (1.8, 3.4)
Self-inflicted	6 621	10.5 (7.8, 14.2)	7.1 (5.0, 10.2)	3.5 (2.1, 5.8)	3.2 (1.9, 5.5)	1.5 (0.7, 3.5)	1.9 (0.9, 3.9)
Drug/alcohol-related	12 925	11.2 (9.1, 13.7)	5.6 (4.2, 7.5)	3.0 (2.0, 4.4)	2.4 (1.6, 3.8)	2.7 (1.8, 4.1)	2.9 (2.0, 4.2)
Violent	10 549	6.6 (4.8, 9.1)	2.7 (1.6, 4.5)	1.6 (0.9, 3.0)	0.9 (0.4, 2.2)	2.2 (1.3, 3.8)	1.7 (0.9, 3.2)
General population <sup>†</sup>		2.7		0.6 <sup>‡</sup>	0.7	1.5	
<b>Boys: 16-17 years</b>	194 750	9.2 (8.6, 9.7)	4.9 (4.5, 5.3)	2.5 (2.3, 2.8)	2.5 (2.2, 2.8)	2.2 (2.0, 2.5)	2.1 (1.8, 2.4)
Accident-related	137 044	7.1 (6.5, 7.7)	3.0 (2.6, 3.4)	1.5 (1.2, 1.7)	1.5 (1.2, 1.8)	2.0 (1.7, 2.3)	2.1 (1.8, 2.4)
Adversity-related	57 706	14.4 (13.2, 15.7)	9.7 (8.7, 10.8)	5.1 (4.4, 5.9)	4.9 (4.2, 5.8)	2.7 (2.2, 3.3)	2.0 (1.6, 2.6)
Self-inflicted	17 708	22.6 (20.0, 25.7)	16.3 (14.1, 18.9)	10.1 (8.4, 12.1)	7.8 (6.3, 9.7)	3.3 (2.3, 4.6)	3.2 (2.2, 4.5)
Drug/alcohol-related	32 246	18.9 (17.0, 20.9)	13.6 (12.0, 15.4)	7.7 (6.6, 9.0)	7.0 (5.8, 8.3)	3.0 (2.3, 3.8)	2.4 (1.8, 3.2)
Violent	27 129	8.7 (7.3, 10.2)	5.2 (4.2, 6.4)	2.0 (1.5, 2.8)	2.6 (1.8, 3.5)	2.1 (1.5, 2.9)	1.4 (0.9, 2.2)
General population <sup>†</sup>		3.5		1.2	1.5	2.2	
<b>Boys: 18-19 years</b>	155 526	13.2 (12.5, 13.9)	8.2 (7.7, 8.8)	3.9 (3.5, 4.3)	4.8 (4.3, 5.3)	2.6 (2.4, 3.0)	2.4 (2.0, 2.7)
Accident-related	86 450	8.8 (8.0, 9.6)	4.3 (3.8, 4.9)	2.3 (1.9, 2.7)	2.1 (1.7, 2.5)	2.5 (2.1, 2.9)	2.0 (1.6, 2.4)
Adversity-related	69 076	19.2 (17.8, 20.6)	13.6 (12.4, 14.8)	6.1 (5.4, 6.9)	8.5 (7.6, 9.5)	2.8 (2.4, 3.4)	2.8 (2.3, 3.5)
Self-inflicted	20 292	30.4 (27.4, 33.7)	23.1 (20.5, 26.0)	11.8 (10.0, 13.8)	14.0 (12.0, 16.4)	3.6 (2.6, 4.8)	3.9 (2.9, 5.4)
Drug/alcohol-related	40 250	25.1 (23.1, 27.3)	18.4 (16.7, 20.3)	8.4 (7.3, 9.6)	11.8 (10.4, 13.4)	3.3 (2.6, 4.1)	3.6 (2.8, 4.5)
Violent	32 916	11.9 (10.5, 13.6)	7.6 (6.4, 9.0)	3.1 (2.4, 4.0)	4.5 (3.6, 5.6)	2.5 (1.9, 3.2)	1.9 (1.4, 2.7)
General population <sup>†</sup>		3.5		1.4	1.9	2.3	
<b>Boys: All</b>	634 439	8.2 (7.9, 8.5)	4.2 (4.0, 4.4)	2.1 (1.9, 2.2)	2.2 (2.0, 2.3)	2.0 (1.9, 2.1)	2.0 (1.9, 2.2)
Accident-related	483 356	6.0 (5.7, 6.3)	2.3 (2.2, 2.5)	1.2 (1.1, 1.3)	1.1 (1.0, 1.2)	1.8 (1.6, 1.9)	1.9 (1.8, 2.1)
Adversity-related	151 083	15.6 (14.8, 16.5)	10.5 (9.8, 11.2)	5.1 (4.6, 5.6)	5.9 (5.4, 6.5)	2.7 (2.4, 3.1)	2.5 (2.1, 2.8)
Self-inflicted	44 621	24.2 (22.4, 26.1)	17.9 (16.3, 19.5)	9.8 (8.7, 11.0)	9.8 (8.7, 11.1)	3.1 (2.5, 3.9)	3.3 (2.7, 4.1)

Drug/alcohol-related	85 421	20.3	(19.1, 21.6)	14.3	(13.3, 15.4)	7.2	(6.5, 8.0)	8.3	(7.5, 9.2)	3.1	(2.7, 3.6)	3.0	(2.5, 3.5)
Violent	70 594	9.9	(8.9, 10.9)	5.9	(5.2, 6.7)	2.5	(2.0, 3.0)	3.2	(2.7, 3.8)	2.3	(1.9, 2.8)	1.7	(1.3, 2.2)
General population <sup>†</sup>	.	3.0				0.9 <sup>‡</sup>		1.1		1.8			

Data presented as risk per 1,000 (95% Confidence Interval), unless otherwise stated.

\*Suicides, homicides and drug/alcohol-related deaths. These deaths were not mutually exclusive. Risks are not reported for homicides due to small counts.

<sup>†</sup>Derived from publicly available life-tables for England and Wales for 1997-2012 (total deaths: Excel sheet 'nlteng1214reg\_tcm77-414444.xls',

<http://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/lifeexpectancies/datasets/nationallifetablesenglandreferencetables>; suicides: Excel sheet 'suicidereferencetablestcm77432201-1.xls' (Table 10), <http://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/deaths/datasets/suicidesintheunitedkingdomreferencetables>. Ten-year risks derived as per Herbert *et al*, Plos Medicine 2015 (Supplementary Table S2).

<sup>‡</sup>Ten-year risks of suicide among 10-15 year olds and 10-19 year olds in the general population are likely to be under-estimated, since rates were not provided for 10-5 year olds in years where there were fewer than 3 death registrations of this type.

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637 **Table S3:** Relative risks of suicide and drug/alcohol-related deaths within 10 years after self-inflicted or drug/alcohol-related index injury (vs. accident-  
 638 related injury), adjusted for age-group, socio-economic status, and chronic conditions, by sex (multivariable analyses)

Combination of self-inflicted or drug/alcohol-related index injury (vs. accident-related) <sup>†</sup>	Cause of death*, Sub-hazard ratio (95% Confidence Interval)									
	Suicide (any)		DA (any)		Suicide (not DA)		DA (no suicide)		Suicide+DA	
Girls										
Self-inflicted (not drug/alcohol-related)	10.31	(6.18 to 17.20)	8.08	(4.38 to 14.89)	9.49	(5.30 to 16.99)	6.39	(2.98 to 13.67)	13.36	(4.61 to 38.65)
Drug/alcohol-related (not self-inflicted)	3.13	(2.05 to 4.78)	4.40	(2.89 to 6.88)	2.65	(1.61 to 4.36)	4.22	(2.60 to 6.85)	4.95	(2.15 to 11.39)
Self-inflicted+drug/alcohol-related	4.95	(3.52 to 6.96)	5.05	(3.50 to 7.30)	4.35	(2.95 to 6.41)	4.35	(2.82 to 6.70)	7.23	(3.54 to 14.79)
Boys										
Self-inflicted (not drug/alcohol-related)	3.65	(2.22 to 6.02)	4.49	(2.78 to 7.25)	3.55	(2.04 to 6.17)	4.55	(2.69 to 7.70)	4.22	(1.33 to 13.43)
Drug/alcohol-related (not self-inflicted)	2.82	(2.29 to 3.46)	3.99	(3.29 to 4.84)	2.77	(2.21 to 3.48)	4.19	(3.39 to 5.17)	3.08	(1.88 to 5.05)
Self-inflicted+drug/alcohol-related	6.77	(5.76 to 7.97)	6.48	(5.45 to 7.70)	6.50	(5.43 to 7.78)	6.11	(5.03 to 7.41)	8.19	(5.60 to 11.98)

639 DA = Drug/alcohol-related

640 Each cell represents a separate Fine & Gray's competing risks model, where the corresponding combination of self-inflicted or drug/alcohol-related index injury (vs. accident-related injury), age-group, socio-  
 641 economic status, and chronic condition status were entered as covariates simultaneously, per model. Sub-hazard ratios for age-group, socio-economic status, and chronic condition status, for each of the thirty  
 642 models are not presented here but were very similar to those presented in Table 2 (conditional on sex and cause of death).

643 \*Regardless of whether index injury also violent or not.

644 †Regardless of whether death also related to homicide or not.

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