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

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Summary

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

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

Findings: Among 333,009 adolescents admitted with adversity-related injury (girls 181,926, boys 181,053), and 649,818 with accident-related injury (girls 166,462, boys 483,356), 4,782 died in the ten years post-discharge (girls 1,312, boys 3,470). Adolescents discharged after adversity-related injury had higher risks of suicide and of drug/alcohol-related death in the next decade than after accident-related injury (adjusted hazard ratios [aHRs] varied from 3·2 [95% CI: 2·7, 3·6] for suicide in boys to 4·7 [3·3, 6·8]for drug/alcohol-related death in girls). Risks of suicide were increased following self-inflicted injury, drug/alcohol related injury, and violent injury (e.g. boys, aHR: 6·2 [5·3, 7·3], 4.5 [3·9, 5·2], 1·4 [1·2, 1·8], respectively vs. accident-related injury). Following each type of index injury, risks of suicide and risks of drug/alcohol-related death were increased by similar magnitudes (e.g. boys with self-inflicted injury vs. accident-related injury, aHR of suicide: 6·2 [5·3, 7·3], drug/alcohol-related injury death: 5·9 [5·0, 7·0]).

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

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Introduction

Evidence from population-based cohort studies suggests that different types of 'adversity-related injury' (self-inflicted [including poisonings], drug/alcohol-related, or violent injury) during adolescence are associated with similar underlying psychosocial problems, including adverse experiences (e.g. maltreatment), poor mental health (e.g. anxiety, depression), and poor social circumstances (e.g. poverty).[1-3] Among the 4% of adolescents (10-19 year olds) who are admitted to hospital with one of these types of adversity-related injury in England, approximately three-quarters of girls and one-third of boys are admitted with injuries related to multiple types of adversity.[4] Despite this apparent overlap between self-inflicted, drug/alcohol-related, and violent injury, most research in these adolescents has focused on specific types of adversity-related injury. A previous study of adolescents admitted to hospital in England as an emergency with any adversity-related injury reported that 1 in 136 girls (7·3 per 1,000) and 1 in 64 boys (15·6 per 1,000) died within the ten years after discharge, and that these risks were similar whether the initial injury was self-inflicted, drug/alcohol-related, or violent.[5] These ten-year risks were approximately twice the risks for adolescents discharged after accident-related injury (girls 3·8 per 1,000 and boys: 6·0 per 1,000) or for the general population of adolescents (girls 3·0 and boys: 3·0).

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

well as suicide, during the subsequent 20 years.[9] No comparable estimates have been published for risks of harm following drug/alcohol-related or violent injury (see panel 'Research in Context').

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

Methods

Study design

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

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

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

We excluded adolescents who did not have sex recorded (885; 0·08%), died during the index admission (1,877; 0·17%), had no valid discharge date (372; 0·03%), or were admitted with injury related to neither adversity nor accidents (94,407; 8·9%; the majority of these latter adolescents were admitted primarily for chronic conditions or complications of surgery).[4]

Study cohort and exposures

Self-inflicted, drug/alcohol-related, violent, and accident-related injuries were identified using ICD-10 codes in HES data (i.e. characteristics that were identified and recorded by clinicians). Details of classification of injury and descriptive statistics of the cohort have been reported elsewhere.[4,5] Briefly, 333,009 adolescents who had at least one adversity-related injury (181,926 girls, 151,083 boys; 20·3% and 24·0% of which had an injury that was also accident-related), and 649,818 with at least one accident-related injury but no adversity-related injury (166,462 girls, 483,356 boys) were identified (Supplementary Figure S1).[5]

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

Outcomes

The primary outcome was cause-specific death between one day and ten years after discharge from the index injury admission. We identified deaths using Office for National Statistics (ONS) mortality data linked to HES (within NHS Digital). We used any ICD-9 or -10 codes in the mortality data (based on the underlying and up to 15 other contributing causes recorded in the death certificate) to categorise deaths into five 'causal' groups (Supplementary Table S1). As Figure 1 illustrates, suicide, drug/alcohol-related, and homicide were not mutually exclusive, but these three groups (i.e. adversity-related deaths), accidental (no codes for adversity-related death, but codes for accidental causes) and 'other' deaths (no codes for adversity-related or accidental deaths) were mutually exclusive. As advised by the ONS, undetermined causes of death (codes E980-E989, Y1-Y34; n=483) were classified as suicide (accounting for 38·1% of all suicides).[13] Deaths with codes indicating an adjourned inquest (U50·9; n=130) were categorised as homicide (80·2% of all homicides).

Demographic and clinical factors

Covariates were included in the analyses, based on previous findings of their relationship with adversity-related injury and death, including sex, age, socio-economic status (SES), and chronic conditions.[5] Age was grouped (10-15, 16-17, 18-19 years) to reflect different recommendations in UK national guidelines for management of self-harm or alcohol misuse according to age, and different stages of social development.[6-8] SES was categorised according to Index of Multiple Deprivation scores based on residential postcode,[14] using quintile cut-off values for England. An adolescent was classified as having an underlying chronic condition if HES records for the index injury admission or any admissions in the previous year included one of a cluster of ICD-10 codes for chronic conditions (Hardelid et al, 2013; Appendix Table 6·3·2).[15] Of the 117,453 adolescents with adversity-related or accident-related injury who had a chronic condition, 93,592 (79·7%) had a physical condition (data not shown). The most common physical condition was chronic respiratory disorder (e.g. asthma, 39·8% to 55·4% by sex and type of injury).[5]

Statistical analyses

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

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

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

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

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

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

We checked model assumptions using log-log plots of the Kaplan-Meier estimate of the survival function and the link test, and assessed their goodness-of-fit using plots of the Nelson-Aalen estimate of the cumulative hazard function against Cox-Snell residuals.[16]

Results

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

19·4% [n=85], boys 36·9% [n=711]) (Table 1). The most frequent causes of death after accident-related index injury were 'other' (overall 37·1% [n=877]; girls 59·2% [n=260], boys 32·0% [n=617]) and accidental (29·3% [n=694]; girls 21·4% [n=94], boys 31·1% [n=600]) (Figure 1, Table 1).

Two thirds of all accidental deaths, 67·8% (n=759) were recorded as transport accidents; this proportion did not differ according to type of index admission (data not shown). Among deaths due to other causes, the most common causes were related to neurological conditions (30·9%, n=473) or cancer/blood disorders (25·1%, n=384; of nine possible groups of ICD codes relating to systems within the body).[15]

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

Adversity-related vs. accident-related index injury

Ten-year cumulative risks of total death after adversity related index injury were 7·3 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 per 64) boys (14·8 to 16·4 per 1,000) (Figure 2, Supplementary Table S2). Cumulative risks were lower after accident-related index injury (girls 3·7 per 1,000, 3·4 to 4·1; boys 6·0, 5·7 to 6·3).

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

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

Ten-year risks of suicide were similar after hospital discharge following self-inflicted index injury and drug/alcohol-related index injury (girls 2·9 vs. 2·5 per 1,000; boys 9·8 vs. 7·2; Figure 3, Supplementary Table S2). Compared with adolescents discharged after accident-related injury, risks of suicide were increased five- to six-fold for

adolescents discharged after self-inflicted or drug/alcohol-related injury (Table 3 shows sub-hazard ratios adjusted for covariates; e.g. for boys the adjusted SHR of suicide after self-inflicted injury was 6·20 [5·27, 7·30] and after drug/alcohol-related injury 4·51 [3·89, 5·24]). Risks of suicide were increased after self-inflicted and after drug/alcohol-related injury, whether the index injury was for either one of these types of injury only, or both (Supplementary Table S3; i.e. comparing between rows, per sex).

Ten-year risks of suicide and of drug/alcohol-related death were similar after each type of index injury. These risks were highest after self-inflicted or drug/alcohol-related index injury (Figure 3; Supplementary Table S2). For example, after self-inflicted injury, the ten-year risk of suicide for girls was 2·9 per 1,000, whereas the ten-year risk of drug/alcohol-related death was 2·7 per 1,000 (Figure 3, Supplementary Table S2). After adjustment for covariates, the increased risks of suicide after self-inflicted and after drug/alcohol-related index injury (vs. accident-related injury) were similar to the risks of drug/alcohol-related death. For example, among boys discharged after self-inflicted injury compared with after accident-related injury, the adjusted SHR was 6·20 [5·27, 7·30] for suicide and 5·91 [4·96, 7·03], for drug/alcohol-related death) (Table 3). These adjusted SHRs were similar whether the death was related to suicide but not drugs/alcohol, drugs/alcohol but not suicide, or both causes (Supplementary Table S3; i.e. comparing between columns).

Socio-demographic and clinical covariates

Boys aged 18-19 years who were discharged after self-inflicted injury or drug/alcohol-related injury had the highest risks of death due to any cause (ten-year risks: 30·4 per 1,000, or 1 per 33, after self-inflicted injury, 25·1 per 1,000, or 1 per 40, after drug/alcohol related injury; Supplementary Table S2). These risks were substantially higher than after accident-related injury (8·8 per 1,000) or for the general population of 18-19 year old boys (8·9 per 1,000). These risks were driven by high risks of suicide and drug/alcohol-related death.

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

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

Adolescents with a chronic condition (vs. none) had a 3- to 4-fold increased risk of death due to any cause, and a 10- to 12-fold increased risk of death due to causes other than adversity or accidents, regardless of the type of index injury (Table 2). For example, for 18-19 year old boys discharged after an adversity-related index injury, the ten-year risk of death due to any cause was 37·5 per 1,000 given a chronic condition and 14·8 per 1,000 given none (data not shown). For 18-19 year old boys discharged after accident-related injury, these risks were 17·5 and 8·8 per 1,000 respectively.

Discussion

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

Strengths and limitations

The main strength of our study is the use of linked NHS emergency admissions and mortality data, which included all injury admissions in England linked to subsequent mortality reacords in England and Wales over 15 years.[13] The population-based cohort of nearly one million 10-19 year olds allowed us to compare risks of cause-specific mortality between different types of index injury admissions. We used time-to-event statistical methods to estimate risks whilst taking into account censoring of outcomes and competing risks of different causes of death.[16] Although we combined index injury admissions across a 15-year period, our conclusions were not sensitive to calendar period (e.g. boys in 1997, adjusted SHR of suicide for adversity-related vs. accident-related injury [95% CI]: 2·6 [1·7, 3·9]; corresponding SHR for boys in 2012: 3·2 [2·2, 4.7]; data not shown).

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

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

Comparison with other studies

Our main finding of similar increases in risks of suicide death following self-inflicted injury and following drug/alcohol related injury has not been previously reported. We report lower ten-year risks of death after admission for self-inflicted injury (girls: 7.7 per 1,000, boys: 24.1 per 1,000; Supplementary Table S2) than the 20-year mortality rates after presentation with self-inflicted injury reported by Hawton et al (girls: 17 per 1,000, boys: 50 per 1,000).[9] These differences may be because Hawton et al studied young people aged 15-25 years and determined mortality after 20 years of follow up. In Hawton et al's study, 60·0% of deaths in girls and 45·6% of those in boys were from suicide (including deaths of undetermined intent and drug/alcohol-related suicides),[9] compared with 39·8% and 43·2% in our study (Table 1).

Implications for practice, policy, and research

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

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

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

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Contributors

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

Conflicts of interest

None to declare.

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Data sources

Hospital Episode Statistics data can be accessed by researchers applying to NHS Digital (previously the Health and Social Care Information Centre for England).

Bespoke extracts and tabulations of mortality data for England and Wales are available to order from the ONS (subject to legal frameworks, disclosure control, resources and agreement of costs, where appropriate). Such enquiries should be made to the mortality team at mortality@ons.gsi.gov.uk.

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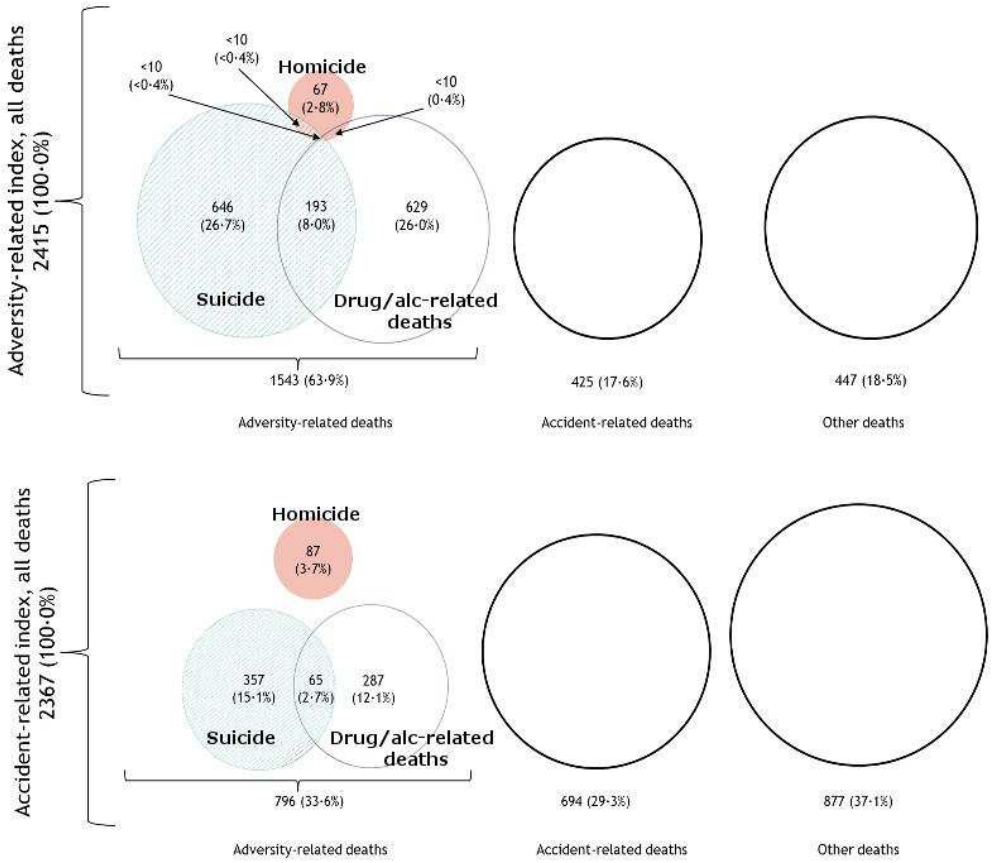

Figure 1: Numbers and proportions of deaths by reported cause

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.

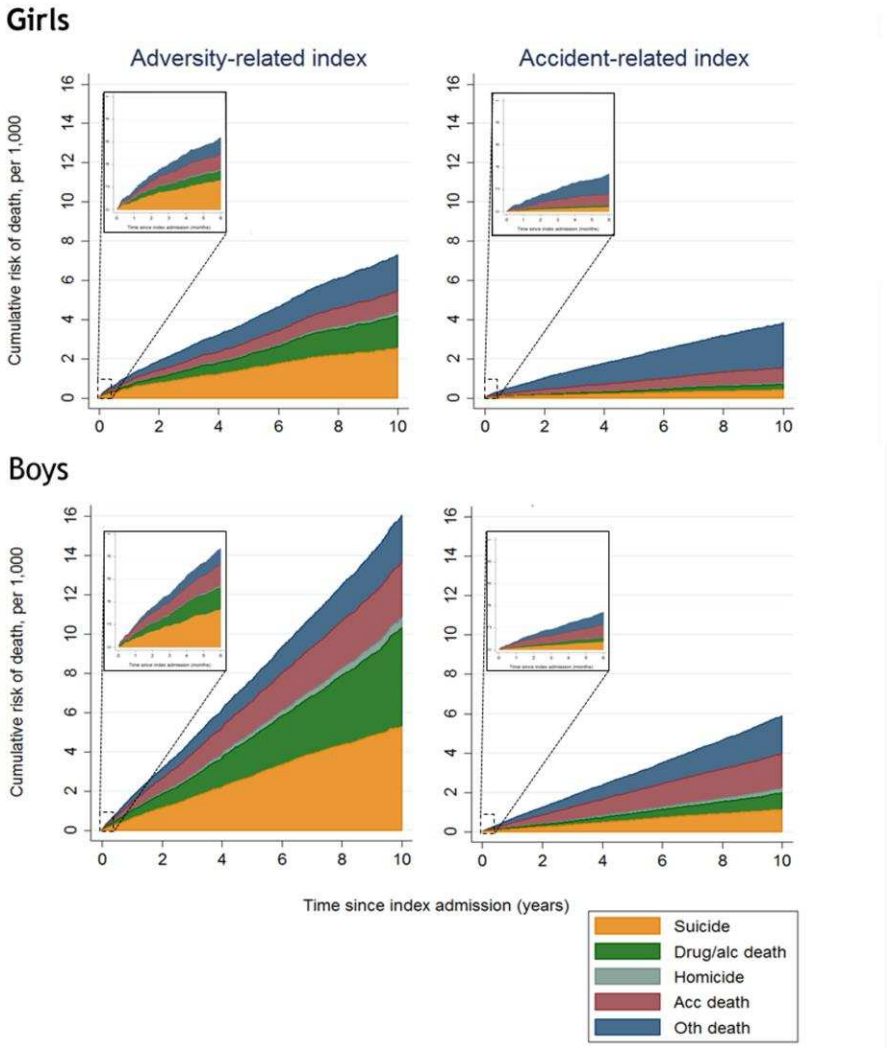

Figure 2: Cumulative risk of cause-specific death over time, by sex and adversity-related or accident-related index injury at admission

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.

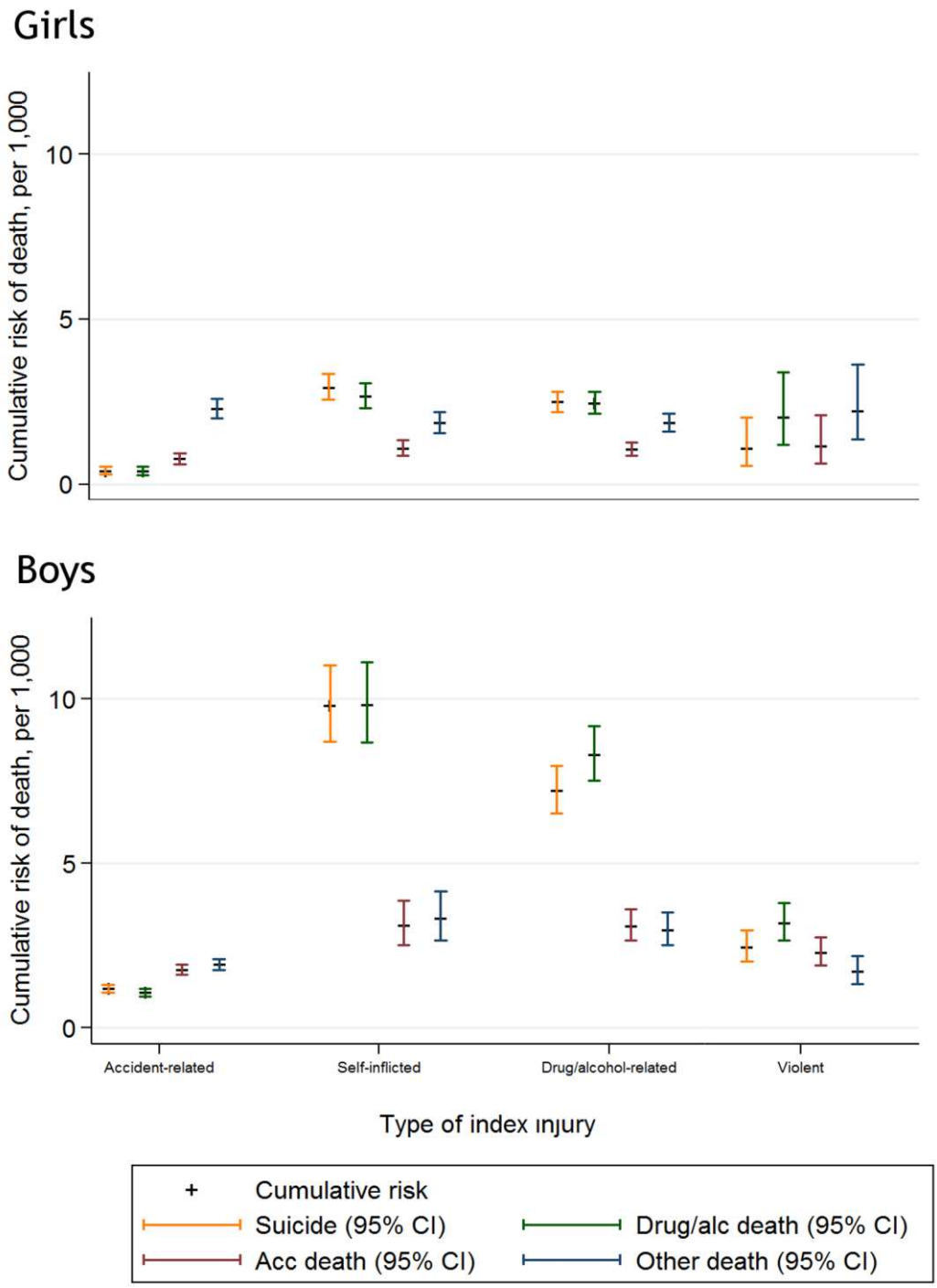

Figure 3: Ten-year cumulative risk of cause-specific deaths, by sex and type of index injury

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

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

		Numbers of deaths by cause (row %)					
Type of injury at index admission	**Discharged**	**Total deaths**	**Adversity-related***	**Suicide**	**DA**	**Accidental**	**Other**
Girls	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)
Boys	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)

DA = Drug/alcohol-related

*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 **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-
548 economic status, and chronic condition status, by sex (multivariable analyses)

	Cause of death, Adjusted sub-hazard ratio (95% Confidence Interval)									
Characteristic at index injury admission	**All deaths**		**Suicide**		**DA death**		**Accidental death**		**Other death**	
Girls										
Adversity- (vs. accident-related) injury	**1·51**	**(1·34 to 1·71)**	**4·54**	**(3·25 to 6·36)**	**4·71**	**(3·28 to 6·76)**	**1.21**	**(0.90 to 1.63)**	**0.64**	**(0.53 to 0.77)**
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										
Adversity- (vs. accident-related) injury	**1·94**	**(1·80 to 2·08)**	**3·15**	**(2·73 to 3·63)**	**3·53**	**(3·04 to 4·09)**	**1·26**	**(1·09 to 1·47)**	**0·99**	**(0·84 to 1·17)**
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)

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)

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

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-group, socio-economic status, and chronic conditions, by sex (multivariable analyses)

	Cause of death, Sub-hazard ratio (95% Confidence Interval)									
Type of adversity-related index injury (vs. accident-related)	**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)

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 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 were very similar to those presented in Table 2 (conditional on sex and cause of death).
DA = Drug/alcohol-related

Panel: Research in context

Systematic review

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

Interpretation

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

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

Annie Herbert, Ruth Gilbert, David Cottrell, Leah Li

Supplementary material

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

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

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

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-related injury), adjusted for age-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 ICD version Descriptions	**CODES**
Suicide	
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)
Drug/alcohol-related death	
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
Homicide	
ICD-9:	
Homicide and injury purposely inflicted by other persons	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
Accidental	
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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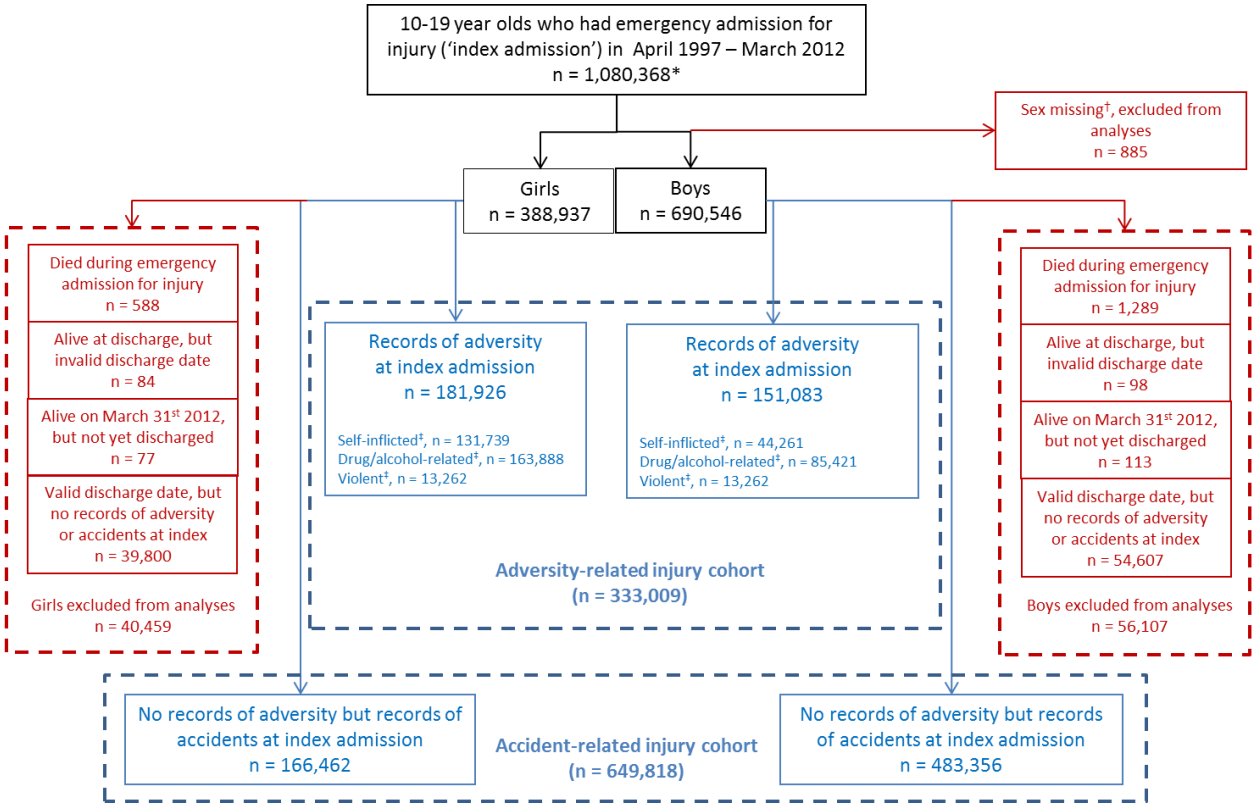

Figure S1: Formation of sub-groups of adolescents with adversity-related and accident-related index injury

This figure has been reproduced and modified from Herbert *et al*, 2015.[5]

* 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 emergency admission for injury.

† Not possible to impute any missing values at 0–30 years old (process for imputing values described in Herbert *et al*, 2015).[5]

‡ Self-inflicted, drug/alcohol-related, and violent injury are not mutually exclusive.

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	
Girls: 10-15 years	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†		2·7				0·2‡		0·2		0·5			
Girls: 16-17 years	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†		3·5				0·3		0·4		0·6			
Girls: 18-19 years	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†		3·5				0·4		0·5		0·5			
Girls: All	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†		3·0				0·3‡		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.

†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: . Ten-year risks derived as per Herbert *et al*, Plos Medicine 2015 (Supplementary Table S2).

‡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.

627 **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
628 for each cause of death for boys

Index injury	N	Total deaths		Adversity-related death*		Suicide		DA death		Accidental death		Other death	
Boys: 10-15 years	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†		2·7				0·6‡		0·7		1·5			
Boys: 16-17 years	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†		3·5				1·2		1·5		2·2			
Boys: 18-19 years	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†		3·5				1·4		1·9		2·3			
Boys: All	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†	.	3·0				0.9‡		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.

†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).

‡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.

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-related injury), adjusted for age-group, socio-economic status, and chronic conditions, by sex (multivariable analyses)

	Cause of death*, Sub-hazard ratio (95% Confidence Interval)									
Combination of self-inflicted or drug/alcohol-related index injury (vs. accident-related)†	**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)

DA = Drug/alcohol-related

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-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 models are not presented here but were very similar to those presented in Table 2 (conditional on sex and cause of death).

*Regardless of whether index injury also violent or not.

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