



Risk of dying unnaturally among people aged 15–35 years who have harmed themselves and inflicted violence on others: a national nested case-control study

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Summary

Background Self-harm and violent criminality have overlapping causes, but people who engage in these behaviours are typically studied as two discrete populations. In this study, we aimed to examine the risk of unnatural death (ie, death from external causes such as accidents, suicide, and undetermined causes) among people with a history of self-harm and violent crime, focusing specifically on those with co-occurring behaviours.

Methods For this population-based nested case-control study, we used national interlinked Danish registers. Individuals aged 35 years or younger, who were alive and residing in the country on their 15th birthday, and who died from external causes (cases) were matched by age and gender to living people (controls). We compared risks of suicide, accidental death, and any death by external causes among those with a history of hospital-treated self-harm, violent criminality, or both behaviours with those in individuals without histories of either behaviour. We estimated incidence rate ratios (IRRs), adjusted for age and gender, to compare risks.

Findings We identified 2246 individuals who died from external causes, whom we matched to 44 920 living controls. 1499 (66.7%) of 2246 individuals died from accidental causes and 604 (26.9%) died by suicide. The risk of unnatural death was elevated for individuals with a history of violence (IRR 5.19, 95% CI 4.45–6.06) or self-harm (12.65, 10.84–14.77), but the greatest risk increase was among those with histories of both behaviours (29.37, 23.08–37.38). Substance misuse disorders, particularly multiple drug use, was more prevalent among individuals with co-occurring self-harm and violence than among those engaging in just one of these behaviours. Psychiatric disorders seemed to account for some of the excess risk of unnatural death among people with dual-harm histories, but excess risk, particularly of accidental death, persisted in the multivariable models.

Interpretation Among individuals with co-occurring self-harm and violence, the risk of accidental death, particularly accidental self-poisoning, should be considered to be as important as the risk of suicide. People with a history of both behaviours who also have a substance misuse disorder are at particularly high risk of dying from external causes. Strategies should be designed to be accessible for people facing turbulent lives with multiple problems. Individuals in this group with both behaviours are likely to be treated by health-care services for self-harm and have contact with criminal justice services, providing multiple opportunities for proactive intervention.

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Introduction

People who harm themselves and those who inflict violence on others are mostly investigated and reported in the literature separately, as two discrete populations. Both suicidality and interpersonal violence incur a huge economic impact through medical and legal costs and loss of productivity,¹ as well as contributing to substantial personal suffering.² In general population settings, only a small subset of individuals who have harmed themselves are violent towards others, although violence is considerably more common in this group than in people without a history of self-harm.³ In clinical populations, such as psychiatric inpatients⁴ and individuals diagnosed with substance misuse disorders,⁵ the co-occurrence proportion between these two behaviours is considerably high. The link between self-harm and subsequent

increased risks of suicide and other external causes of death is well known.^{6,7} Furthermore, individuals with violent histories are at a markedly elevated risk of suicidality compared with those without such histories, in both psychiatric settings⁸ and the general population.^{8–10} However, the risks associated with self-harm and violence co-occurring in the same individual (from this point referred to as dual harm) requires a better understanding.¹¹

Some evidence exists indicating that the trajectories for self-harm and violence overlap, with both behaviours typically emerging during adolescence.^{3,12} Additionally, self-harm and violence share some risk factors,¹³ such as family problems and physical health conditions. There are also shared risk factors for suicide and other external causes of death (male gender, age younger than 35 years, and psychiatric treatment).¹⁴ However, differences in

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Research in context

Evidence before this study

We did searches on literature databases (Web of Knowledge, MEDLINE, PubMed, and Ovid) up to April 30, 2018, with no language restrictions. We used the following search terms to search article titles, modified for each database: "self harm OR self-harm OR self injur* OR self-injur* OR self poison* OR self-poison* OR suicid* OR parasuicide OR accident*" AND "violen* OR aggress* OR assault* OR homicid* OR murder* OR kill". Evidence on the increased risk of suicide among individuals with a history of self-harm is extensive. However, evidence about risks of suicidality, as well as death from other unnatural causes, among individuals who engage in violence against others is sparse. Furthermore, risks among people engaging in both self-harm and violence are not clearly understood because they are usually studied separately. Although some shared risk factors exist for self-harm and violence, there are also differences in the characteristics of individuals engaging in the two behaviours. Much of the existing evidence is specific to patients in particular settings, such as inpatients, or to those with a particular psychiatric diagnosis.

Added value of this study

Our findings support existing evidence that people who have engaged in violence or self-harm have an increased risk of dying from external causes. Our findings extend this evidence by suggesting that individuals with dual histories of self-harm and violence are especially susceptible to dying accidentally, particularly from accidental self-poisoning. We also observed an

increased prevalence of substance misuse disorders, particularly multiple drug misuse, in individuals with histories of self-harm or violence, but particularly so among those who had engaged in both behaviours.

Implications of all the available evidence

Addressing increased risk of suicide is often focused on people with a history of self-harm. However, for individuals who have harmed themselves and who have also inflicted violence on other people, preventing accidental death should be a priority too. Individuals with dual-harm histories are likely to have distinct needs and multiple problems, such as multiple substance misuse. The greatly increased risk of fatal accidental self-poisoning in the dual-harm group requires careful attention, given that these cases accounted for more than half of all deaths from external causes in this group. Individuals with dual-harm histories and a substance misuse disorder had a particularly high risk of dying from external causes. Although effective approaches for reducing risk among these people are likely to be complex and require coordinated efforts across services, interventions addressing one harmful behaviour might have beneficial effects on other risky or damaging behaviours. Many of these individuals are likely to have frequent contact with criminal justice agencies and with health-care and social services, and these should be seen as opportunities for preventive intervention.

characteristics between individuals who engage in self-harm, violence, or both damaging behaviours have also been reported.^{13,15} For example, in one study,¹³ hopelessness was found to predict suicide but not violence. Another study¹⁵ found that violent behaviour was more strongly associated with substance misuse than self-harm behaviour, whereas mood disorders were more strongly associated with self-directed violence. A study¹⁶ of young people in the UK found several characteristics that distinguished individuals with dual-harm histories from those who had only self-harmed. People who had engaged in both behaviours were more likely to have particular personality features, including difficulties with self-control and higher neuroticism. These individuals were more likely to have been exposed to childhood maltreatment and to have been a target of multiple types of victimisation. Additionally, these individuals used self-harm methods with higher lethality than those who had engaged only in self-harm behaviours, and had higher rates of psychotic symptoms and cannabis and alcohol dependence.¹⁶

The risk of unnatural death among people with dual histories of self-harm and violence is unknown. Given that the characteristics of individuals with histories of either self-harm or violence are distinct, we hypothesised that the risks of unnatural death in the dual-harm group

would differ from those in the two single-harm groups; specifically, that risks would be higher in the dual-harm group. It is unknown if factors associated with suicide and accidental death for people with dual-harm histories are similar to those with single-harm histories (ie, either self-harm or violence). A 2015 systematic review¹¹ of the co-occurrence of violence and self-harm identified a need for research to better understand individuals who engage in both behaviours, including a greater understanding of risk factors. Given that there are differences in the prevalence and severity of psychosocial problems, psychiatric symptoms, and substance misuse between single-harm and dual-harm groups,^{13,15} we were interested in quantifying relative risks of unnatural death after adjusting for psychiatric disorders and socioeconomic position. For the same reason, we wished to discern differences in the prevalence of psychiatric disorders, substance misuse, and low parental income between the dual-harm and single-harm groups.

Linked administrative registers provide a unique data source for addressing this research question because of population-level coverage and the capacity to link data from health services, criminal records, and mortality statistics. Existing studies have been done in selected samples, such as inpatient settings, or among people with specific psychiatric diagnoses, such as schizophrenia.^{17,18}

The objectives of our register-based study were first, to compare risks of dying unnaturally among individuals with histories of self-harm or violent criminality alone versus those who had engaged in both behaviours; second, to estimate the prevalence of secondary care-treated psychiatric disorders, substance misuse disorders, and low parental income among individuals with and without histories of self-harm and violent criminality who died by an external cause; and third, to assess the potential confounding influences of psychiatric disorders and parental socioeconomic position on the observed associations.

Methods

Study design and population

We did a nested case-control study of a cohort of people born in Denmark to native Danish parents during 1980–2000 and who were alive and residing in the country on their 15th birthday ($n=1.08$ million). We used registry data in which each resident was assigned a unique personal identification number, enabling accurate linkage between multiple administrative registers with complete national population coverage. We defined cases as people who died from external causes. Dates of death were extracted from the Civil Registration System, with specific causes identified with the Causes of Death Register¹⁹ and classified according to the tenth revision of the International Classification of Diseases coding (ICD-10 as follows: any death by external causes (V01–Y98), suicide (X60–X84, Y870), intentional self-poisoning (X60–X69), violent suicide method (X70–X84), accident (V01–X59), unintentional self-poisoning (X40–X49), and other accident (V01–X59, excluding X40–X49).

Controls were sampled from individuals who were alive when a case individual died, matched by gender and date of birth. Controls were matched to each case by use of incidence density sampling.^{20,21} This process involved selecting controls for each case individual by use of their date of death (the index date). For controls, the index date was the date of matching, according to the criterion that controls had to be alive on that date to be eligible for sampling. The controls were selected randomly from an eligible pool of individuals of the same gender and date of birth as the case individual and were alive at their date of death. Matching for the date of birth ensured that each individual and their matched controls were exactly the same age, which controlled for potential confounding effects of age and calendar time on the estimated association between exposure and outcome. Individuals could be selected as controls for more than one case. To maximise statistical power and precision, 20 controls were matched to each case. Approval for this study was granted by the Danish Data Protection Agency, the Danish Health Data Authority, and Statistics Denmark. This study did not need approval from the Danish National Committee on Health Research Ethics and the requirement for informed consent was waived because only registry data was used.

	Cases	Matched living controls	IRR (95% CI)
Any external cause of death			
Neither behaviour	1586/2246 (70.6%)	42 806/44 920 (95.3%)	1 (ref)
Violence alone	228/2246 (10.2%)	1282/44 920 (2.9%)	5.19 (4.45–6.06)
Self-harm alone	287/2246 (12.8%)	678/44 920 (1.5%)	12.65 (10.84–14.77)
Both behaviours	145/2246 (6.5%)	154/44 920 (0.3%)	29.37 (23.08–37.38)
Suicide			
Neither behaviour	360/604 (59.6%)	11 443/12 080 (94.7%)	1 (ref)
Violence alone	50/604 (8.3%)	379/12 080 (3.1%)	4.36 (3.17–6.01)
Self-harm alone	150/604 (24.8%)	198/12 080 (1.6%)	28.88 (22.17–37.61)
Both behaviours	44/604 (7.3%)	60/12 080 (0.5%)	26.69 (17.54–40.61)
Intentional self-poisoning			
Neither behaviour	49/119 (41.2%)	2238/2380 (94.0%)	1 (ref)
Violence alone	10/119 (8.4%)	74/2380 (3.1%)	6.95 (3.25–14.88)
Self-harm alone	48/119 (40.3%)	52/2380 (2.2%)	52.21 (29.32–92.99)
Both behaviours	12/119 (10.1%)	16/2380 (0.7%)	30.94 (13.48–71.00)
Violent suicide method			
Neither behaviour	311/485 (64.1%)	9205/9700 (94.9%)	1 (ref)
Violence alone	40/485 (8.3%)	305/9700 (3.1%)	4.00 (2.80–5.70)
Self-harm alone	102/485 (21.0%)	146/9700 (1.5%)	24.23 (17.91–32.79)
Both behaviours	32/485 (6.6%)	44/9700 (0.5%)	25.60 (15.71–41.71)
Accident			
Neither behaviour	1136/1499 (75.8%)	28 634/29 980 (95.5%)	1 (ref)
Violence alone	156/1499 (10.4%)	822/29 980 (2.7%)	5.22 (4.33–6.30)
Self-harm alone	117/1499 (7.8%)	441/29 980 (1.5%)	7.20 (5.78–8.95)
Both behaviours	90/1499 (6.0%)	83/29 980 (0.3%)	31.64 (23.06–43.42)
Unintentional self-poisoning			
Neither behaviour	104/314 (33.1%)	5864/6280 (93.4%)	1 (ref)
Violence alone	66/314 (21.0%)	260/6280 (4.1%)	14.06 (9.90–19.96)
Self-harm alone	68/314 (21.7%)	129/6280 (2.1%)	31.01 (21.08–45.62)
Both behaviours	76/314 (24.2%)	27/6280 (0.4%)	195.50 (110.23–346.74)
All other types of accident			
Neither behaviour	1032/1185 (87.1%)	22 770/23 700 (96.1%)	1 (ref)
Violence alone	90/1185 (7.6%)	562/23 700 (2.4%)	3.69 (2.91–4.68)
Self-harm alone	49/1185 (4.1%)	312/23 700 (1.3%)	3.54 (2.60–4.84)
Both behaviours	14/1185 (1.2%)	56/23 700 (0.2%)	5.87 (3.26–10.58)

Data are n/N (%), unless otherwise specified. IRRs adjusted inherently for age and gender in the matched design. Of the 2246 deaths from external causes among cases, the other 143 unnatural deaths were classified as deaths of undetermined intent ($n=69$ [3.1%]), homicides ($n=59$ [2.6%]), and other unnatural deaths ($n=15$ [0.7%]). IRR=incidence rate ratio.

Table 1: IRRs for death by specific external causes among people with histories of self-harm alone, violent criminality alone, or both behaviours

Exposures

Exposure status was classified as three mutually exclusive categories: histories of self-harm alone, violent criminality alone, or self-harm plus violent criminality. Hospital-treated self-harm episodes, including those resulting in admissions to general hospitals and psychiatric units (from 1990 onwards) and those resulting in presentations to a general hospital emergency department and treatment in psychiatric unit outpatient clinics (from 1994 onwards), were identified from the National Patient Register²² and the Psychiatric Central Research Register²³

For the International Classification of Diseases see <https://www.who.int/classifications/icd/icdonlineversions/en/>

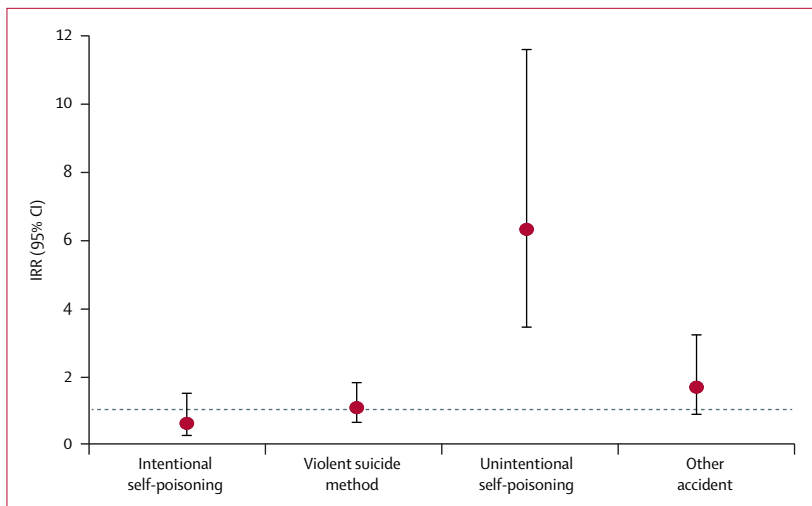


Figure 1: IRRs for specific external causes of death among people with histories of self-harm plus violent criminality versus those with a history of self-harm alone

IRRs adjusted inherently for age and gender in the matched design. IRR=incident rate ratio.

See [Online](#) for appendix

by applying a previously derived coding algorithm (appendix p 1).²⁴ This definition of self-harm encompasses non-fatal acts done with intent to inflict harm on oneself, with or without suicidal intent, including self-poisoning and self-injury.^{3,25,26} The very low numbers of incident cases in the register before the 1990s indicate that self-harm episodes might not have been fully recorded before that decade and, therefore, we restricted the study cohort to individuals born from 1980 onwards. Information regarding violent crimes was extracted from the National Crime Register.²⁷ We used a broad definition of violent crime to include threats to safety and intimidation, as well as physical assault.²⁸ Specifically, we included homicide, assault, robbery, aggravated burglary or arson, possessing a weapon in a public place, violent threats, extortion, human trafficking, abduction, kidnapping, rioting and other public order offences, terrorism, and sexual offences. Generally, we applied the date when the criminal act was recorded as occurring. If this date was unregistered (less than 0.3% of all violent offences), we applied the conviction date instead.

For violent criminality, measurement of exposure status in individuals began on their 15th birthday—the age of criminal responsibility in Denmark—for the period between Jan 1, 1995, and Dec 31, 2015. For self-harm episodes, measurement of exposure status began on the tenth birthday of individuals in the cohort, on the basis of the age of onset of self-harm observed in population cohorts,^{29,30} for the period between Jan 1, 1990, and Dec 31, 2015. Therefore, individuals in our study were aged between 15 and 35 years.

Covariates

Information was extracted from the Psychiatric Central Research Register²³ to enable adjustment for secondary care-treated psychiatric disorders and substance misuse

disorders, occurring at any time before the index date. We derived information on individuals' socioeconomic position from variables relating to parental income, parental educational attainment level, and parental employment status at the time of a cohort individual's 15th birthday, extracted from the Integrated Database for Labour Market Research.³¹ Low parental income was defined as household income being in the lowest quartile in the year of a cohort individual's 15th birthday.

Statistical analysis

We estimated incidence rate ratios (IRRs) for the two single-harm exposure categories (self-harm alone and violence alone) and the dual-harm category (both self-harm and violence) versus a generic reference category of neither behaviour, in relation to the unnatural mortality outcomes examined. We fitted conditional logistic regression models to generate exposure odds ratios comparing exposure prevalence values between cases and controls that can be interpreted as IRRs (ie, relative risks), which were further adjusted for psychiatric disorders, substance misuse, and socioeconomic position. We also examined the prevalence of secondary care-treated psychiatric disorders, substance misuse disorders, and low parental income by use of conditional Poisson regression. We determined that the fitted Poisson models were not over-dispersed by fitting a negative binomial model and testing the null hypothesis that the additional parameter did not differ significantly from zero. The Poisson models generated prevalence values for each exposure group and estimated prevalence ratios between exposure groups. All analyses were done with Stata Release, version 15.²⁶ We did a post-hoc analysis to examine the excess risks in the dual-harm group by estimating IRRs for specific causes of suicide and accidental death by use of the self-harm alone group as an alternative reference group, given that individuals who have self-harmed are known to have an increased risk of suicide.⁶

Role of the funding source

The funder of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report. MJC and SS had access to the raw data. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Results

We identified 2246 deaths from external causes during the follow-up period (Jan 1, 1995–Dec 31, 2015), and these cases were matched to 44920 living controls. 1499 (66.7%) of these deaths were accidental and 604 (26.9%) were suicides (table 1). The other 143 (6.4%) unnatural deaths were classified as deaths of undetermined intent (69 [3.1%] of 2246), homicides (59 [2.6%]), and so-called other unnatural deaths (15 [0.7%])—ie, legal interventions

involving discharge of firearms, operations of war, and complications of medical and surgical care. During the observation period, death by external causes occurred at a median age of 21.1 years (IQR 18.6–24.9). Fatal unintentional self-poisoning was preponderant among individuals who had harmed themselves and committed violent crime (76 [52.4%] of 145) compared with those with a history of self-harm alone (68 [23.7%] of 287) or violent criminality alone (66 [28.9%] of 228) and those who had engaged in neither type of harmful behaviour (104 [6.6%] of 1586). Most deaths from accidental poisoning (273 [86.9%] of 314) involved narcotics, psychodysleptic or hallucinogenic drugs (ICD-10 code X42), or other unspecified substances (X44). Further characteristics of cases and controls are presented in the appendix (p 4).

Compared with individuals without histories of either harmful behaviour, the risk of dying by any external cause was elevated in individuals with a history of violence or self-harm and was further increased in individuals who had engaged in both behaviours (table 1). The risk of accidental death among individuals with dual-harm histories was particularly increased, with the risk of unintentional self-poisoning in this exposure group being the highest IRR observed in this study (table 1). This association was much stronger than that between having a history of self-harm alone and death from unintentional self-poisoning (table 1). Figure 1 shows IRRs for specific causes of suicide and accidental death for individuals with dual-harm histories versus people with a history of self-harm alone. The risk of fatal unintentional self-poisoning was significantly higher in people who had enacted both behaviours than in people who only self-harmed, but the risks of intentional self-poisoning, suicide by violent method, and accidental death other than by unintentional self-poisoning did not vary significantly between these two exposure groups.

Among individuals who died from any external cause, the prevalence of substance misuse disorders was markedly higher among people with dual-harm histories compared with those with a history of one of the behaviours alone (table 2). After assessing the types of drugs used by individuals with dual-harm histories who died from any external cause, we found an especially high prevalence of misuse of multiple drugs (51.7%, 95% CI 43.6–59.7); this prevalence was even higher among those in the dual-harm group who died from accidental self-poisoning (65.8%, 54.4–75.6; appendix p 5). The prevalence of low parental income was higher in the dual-harm group (34.5%, 27.2–42.6) than in the self-harm alone group (21.6%, 17.2–26.7). Prevalence ratio analyses indicated that deceased individuals with a dual-harm history had higher prevalences of substance misuse disorders (prevalence ratio 1.79, 95% CI 1.36–2.36) and low parental income (1.60, 1.10–2.32) than those of individuals with a history of self-harm alone, but there was no statistically significant evidence of a higher prevalence of any psychiatric disorder (1.11, 0.89–1.38) in the dual-harm group.

	n	Prevalence, % (95% CI)
Any mental illness (F00–F99)		
Neither behaviour	250	15.8% (14.1–17.6)
Violence alone	85	37.3% (31.2–43.8)
Self-harm alone	227	79.1% (74.0–83.4)
Both behaviours	127	87.6% (81.1–92.1)
Substance misuse disorders (F10–F19)		
Neither behaviour	70	4.4% (3.5–5.5)
Violence alone	52	22.8% (17.8–28.7)
Self-harm alone	107	37.3% (31.9–43.0)
Both behaviours	97	66.9% (58.8–74.1)
Schizophrenia spectrum disorders (F20–F29)		
Neither behaviour	48	3.0% (2.3–4.0)
Violence alone	13	5.7% (3.3–9.6)
Self-harm alone	82	28.6% (23.6–34.1)
Both behaviours	41	28.3% (21.5–36.1)
Mood or affective disorders (F30–F39)		
Neither behaviour	66	4.2% (3.3–5.3)
Violence alone	11	4.8% (2.7–8.5)
Self-harm alone	97	33.8% (28.6–39.5)
Both behaviours	36	24.8% (18.5–32.5)
Anxiety disorders (F40–F48)		
Neither behaviour	85	5.4% (4.4–6.6)
Violence alone	33	14.5% (10.5–19.7)
Self-harm alone	143	49.8% (44.1–55.6)
Both behaviours	68	46.9% (38.9–55.0)
Personality disorders (F60)		
Neither behaviour	34	2.1% (1.5–3.0)
Violence alone	16	7.0% (4.3–11.1)
Self-harm alone	81	28.2% (23.3–33.7)
Both behaviours	52	35.9% (28.5–44.0)
Childhood behavioural disorders (F90–F98)		
Neither behaviour	66	4.2% (3.3–5.3)
Violence alone	29	12.7% (9.0–17.7)
Self-harm alone	36	12.5% (9.2–16.9)
Both behaviours	38	26.2% (19.7–34.0)
Any other disorder		
Neither behaviour	84	5.3% (4.3–6.5)
Violence alone	26	11.4% (7.9–16.2)
Self-harm alone	82	28.6% (23.6–34.1)
Both behaviours	54	37.2% (29.8–45.4)

Psychiatric disorder categories are from the tenth edition of the International Classification of Diseases.

Table 2: Prevalence of secondary care-treated psychiatric disorders among individuals who died by any external cause

Adjusting IRRs for hospital-treated psychiatric disorders, substance misuse disorders, and parental socioeconomic position attenuated the elevated risks observed across the range of cause-specific mortality outcomes examined (table 3). The marked increase in the risk of unintentional self-poisoning in individuals with histories of both self-harm and violence persisted after full adjustment (table 3). For intentional self-poisoning, suicide by violent method,

	IRR initial adjustment (95% CI)	IRR full adjustment (95% CI)
Any external cause of death (n=2246)		
Neither behaviour	1 (ref)	1 (ref)
Violence alone	5.19 (4.45–6.06)	3.33 (2.82–3.93)
Self-harm alone	12.65 (10.84–14.77)	5.83 (4.88–6.97)
Both behaviours	29.37 (23.08–37.38)	8.62 (6.52–11.40)
Suicide (n=604)		
Neither behaviour	1 (ref)	1 (ref)
Violence alone	4.36 (3.17–6.01)	2.72 (1.91–3.87)
Self-harm alone	28.88 (22.17–37.61)	10.57 (7.79–14.34)
Both behaviours	26.69 (17.54–40.61)	7.08 (4.36–11.50)
Intentional self-poisoning (n=119)		
Neither behaviour	1 (ref)	1 (ref)
Violence alone	6.95 (3.25–14.88)	5.57 (2.37–13.12)
Self-harm alone	52.21 (29.32–92.99)	17.02 (8.55–33.87)
Both behaviours	30.94 (13.48–71.00)	10.87 (3.92–30.16)
Violent suicide method (n=485)		
Neither behaviour	1 (ref)	1 (ref)
Violence alone	4.00 (2.80–5.70)	2.43 (1.64–3.58)
Self-harm alone	24.23 (17.91–32.79)	9.15 (6.45–12.99)
Both behaviours	25.60 (15.71–41.71)	6.56 (3.72–11.59)
Accident (n=1499)		
Neither behaviour	1 (ref)	1 (ref)
Violence alone	5.22 (4.33–6.30)	3.53 (2.89–4.32)
Self-harm alone	7.20 (5.78–8.95)	3.70 (2.87–4.76)
Both behaviours	31.64 (23.06–43.42)	9.97 (6.87–14.47)
Unintentional self-poisoning (n=314)		
Neither behaviour	1 (ref)	1 (ref)
Violence alone	14.06 (9.90–19.96)	6.29 (4.13–9.57)
Self-harm alone	31.01 (21.08–45.62)	7.22 (4.26–12.24)
Both behaviours	195.50 (110.23–346.74)	32.80 (15.94–67.49)
All other types of accident (n=1185)		
Neither behaviour	1 (ref)	1 (ref)
Violence alone	3.69 (2.91–4.68)	3.01 (2.36–3.84)
Self-harm alone	3.54 (2.60–4.84)	2.69 (1.93–3.75)
Both behaviours	5.87 (3.26–10.58)	3.72 (1.97–7.01)

In the initial adjustment, estimates were adjusted inherently for age and gender in the matched design. In the full adjustment, estimates were additionally adjusted for substance misuse disorders, other hospital-treated psychiatric disorders, and socioeconomic position (incorporating parental income, parental educational attainment, and parental employment status on the child's 15th birthday). IRR=incident rate ratio.

Table 3: IRRs for death by specific external causes among people with histories of self-harm alone, violent criminality alone, or both behaviours—comparison between initial and full adjustment of the estimates

and accidental death other than unintentional self-poisoning, we found no evidence of a higher risk among individuals with dual-harm histories versus those who had engaged in one of the two behaviours. When compared with individuals with self-harm histories alone, fatal unintentional self-poisoning risk was independently and markedly elevated among individuals with co-occurring self-harm and violence (appendix p 6).

For individuals with a history of violent criminality alone, the IRRs of death by any external cause were

similar after additional adjustment for psychiatric diagnoses, socioeconomic position, and both variables simultaneously (figure 2). The additional adjustment for socioeconomic position did not greatly attenuate the increased risk of dying unnaturally among individuals with a history of self-harm alone, but adjusting for psychiatric disorder resulted in a marked attenuation of the IRR. A post-hoc analysis showed that this attenuation was seen for both suicide and accidental death, but was most pronounced for suicide deaths (appendix pp 2, 3). The largest attenuations observed were among individuals who had engaged in both harmful behaviours; here, again, the confounding influence of psychiatric disorders was far greater than that of socioeconomic position.

Discussion

In this study, we found that the risk of dying unnaturally was markedly increased among individuals with a history of either self-harm or violent criminality. However, we found an even greater elevated risk of accidental death, particularly accidental self-poisoning, among people with dual-harm history compared with those with either a history of self-harm or violence. Most deaths by external causes among individuals with dual-harm histories were unintentional self-poisonings. Among these cases of unintentional poisoning, we observed an increased prevalence of substance misuse in individuals with single histories of self-harm or violence, but the prevalence was particularly high among individuals who had engaged in both behaviours, with prevalence of multiple drug misuse being especially high in this group. Psychiatric disorders were associated with some of the excess risk of unnatural death among people with dual-harm histories, but excess risk, particularly of accidental death, persisted in the multivariable models.

These findings support existing evidence of elevated risk of dying unnaturally among people who have engaged in violent behaviour.⁸ Furthermore, our findings suggest that individuals with a history of both self-harm and violence are particularly susceptible to dying accidentally, most often by unintentional self-poisoning. In the UK, national clinical guidelines on the effective treatment for people who have harmed themselves focus on suicide risk.⁷ It is common practice for mental health assessments to be done in individuals who attended hospital after having self-harmed.⁷ Furthermore, psychosocial assessments have been associated with a reduced risk of further harm in these individuals.³² Given that accidental deaths occurred more commonly than suicide among people in our dual-harm exposure group, individuals presenting with self-harm who have also inflicted violence on others should be assessed for potential risk factors associated with dying accidentally, including impulsivity and substance misuse. All individuals in our study who were identified as having a history of a violent behaviour and self-harm had contact

with the criminal justice system and with health services, offering multiple opportunities for enhanced monitoring, assessment, and intervention.

Co-occurrence of self-harm and violent behaviour is likely to result from a complex interplay of factors including childhood adversity—such as parental psychiatric disorder or substance misuse (or both), divorce, abuse, personality features, and poverty—and genetics.^{16,28,33} Exposure to such factors can lead to psychological processes that increase risks of suicide and violence, such as emotional dysregulation, impulsivity, and interpersonal difficulties, as well as psychiatric disorders.³⁴ We found similar risks of suicide among people with dual histories of self-harm and violence and among those with a history of self-harm alone, which suggests that much of the increased suicide risk might be associated with psychiatric diagnoses, substance misuse, and socioeconomic position (additional factors that we adjusted for). However, even after comprehensive covariate adjustment, excess risk of accidental death persisted among individuals with dual histories of self-harm and violence. This suggests that effective strategies will need to consider a broad range of factors. Therapeutic approaches should help individuals to develop alternative methods of emotional regulation—for example, mindfulness-based approaches and dialectical behaviour therapy, which might help to reduce harmful behaviours.^{16,35}

In the UK, rates of mental health service use by people who have self-harmed and perpetrated violence have been reported to be similar to rates among people with a history of self-harm alone.¹⁶ This is concerning, given our finding of a higher prevalence of substance misuse and much higher risk of accidental death among people with dual-harm histories than among individuals with a history of self-harm alone, suggesting that this group has specific needs. People with dual-harm histories have also been found to have more social and interpersonal adversity, distinct personality features, and lower levels of self-control.¹⁶ Prevention and treatment strategies should consider the multiple health and social needs of this group and the personality traits and barriers that might play a part. These considerations are likely to require effective and coordinated input from several agencies including health-care services, the criminal justice system, and social services. Community and school-based programmes, tailored for specific social contexts and with long-term commitment, could help to prevent early onset of risky behaviours contributing to premature death.³⁶

Illicit substance misuse has been found to be a specific risk factor for unintentional self-poisoning¹⁴ and for all-cause mortality.³⁷ In our study, we found particularly high risks of accidental self-poisoning involving narcotic and hallucinogenic drugs among individuals with dual-harm histories. High prevalence of substance misuse disorder might reflect impulsivity in individuals engaging in both violence and self-harm. A meta-analysis³⁸ of studies

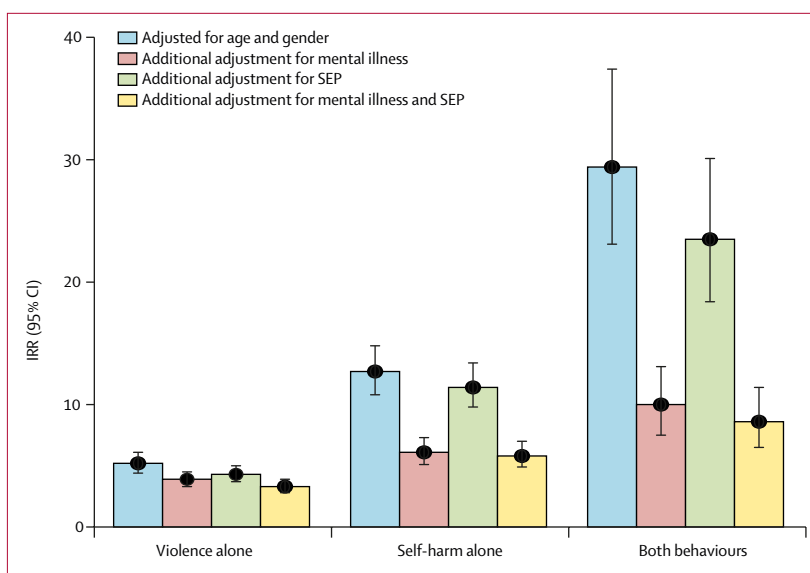


Figure 2: Comparison of different levels of adjustment in estimated IRRs for death by any external cause across the three behavioural exposure categories

The reference group was individuals without histories of either behaviour. IRR=incident rate ratios. SEP=socioeconomic position.

examining violence risk in individuals with schizophrenia found that increased risk was mediated by comorbid substance misuse. Recommendations for treatment and follow-up for individuals with dual-harm history could include referrals to specialist drug and alcohol services. However, evidence also exists that a greater propensity towards violence among people with a psychiatric disorder might be attributed to risk factors similar to those present in the general population, such as negative life events, lack of social support,³³ and unemployment.³⁹ Recommendations⁴⁰ highlight that effective suicide prevention strategies should encompass social, interpersonal, and individual factors and, therefore, are likely to need to address violence and premature death from causes other than suicide. Finally, some evidence suggests that suicide prevention initiatives can also have an effect on correlated adverse outcomes, such as interpersonal violence;⁴¹ likewise, effective interventions to prevent violent behaviour or alcohol misuse might help to reduce the risk of suicide.^{8,42}

The key strength of our study is the use of nationally representative population-level data from well powered Danish registries, enabling the examination of risk of dying unnaturally as a rare outcome among uncommon exposure groups in the population. Because of the low incidence of suicide and other external causes of death, few datasets worldwide are adequately powered to enable examination of these risks in individuals with dual histories of self-harm and externalised violence. The findings of this study are likely to be generalisable to other high-income nations because of its population-level coverage.

Our study has some limitations. Although we adjusted for hospital-treated psychiatric disorders, both cases and

controls might have had an undetected and undiagnosed psychopathology or received treatment only in primary care. Although having histories of self-harm or violent criminality were found to be associated with distinct risk profiles in this study, these harmful behaviours are also likely to be markers for a range of psychosocial adversities. Adjusting for psychiatric disorders and socioeconomic position attenuated the IRRs, but only partly, suggesting that the two behaviours could be markers for other factors, such as childhood adversity and emotional and behavioural regulation difficulties.³ However, the registry data that were available for examination did not provide this level of detail. Epidemiological studies are rarely able to capture all episodes of self-harm, because most happen in the community.^{4,5} We only included self-harm episodes that were treated in hospital emergency departments or outpatient clinics or that resulted in admission; therefore, we cannot infer that our results would be similar for individuals who self-harmed but were not treated in a hospital. Similarly, violent episodes by individuals who engaged in violent behaviour without contact with the criminal justice system could not be identified.

Suicide risk is often the focus for individuals with a history of self-harm, but we found that risk of accidental death was also markedly increased in people with histories of either self-harm or violent criminality. Individuals with co-occurring self-harm and violence were at a particularly elevated risk of accidental death, and prevalence of substance misuse was also much higher among these individuals than in those with histories of either self-harm or violent criminality. Notably, their high risk of fatal unintentional self-poisoning requires careful attention, given that these cases accounted for more than half of all deaths from external causes in this dual-harm exposure group. Although one single effective approach is unlikely to exist for tackling the complex needs of these people, interventions addressing one harmful behaviour might have beneficial effects on other risky or damaging behaviours. Many of these individuals are likely to have frequent contact with criminal justice agencies and with health-care and social services, providing multiple opportunities for proactive and coordinated preventive interventions.

Contributors

SS, MJC, PLHM, CBP, and RTW were responsible for the study concept and design. RTW acquired funding. MJC and SA did the data management and statistical analyses. SS, MJC, PLHM, CBP, RTW, and NK interpreted the results. SS drafted the manuscript. All authors critically reviewed the manuscript.

Declaration of interests

NK was Chair of the Guideline Development Group for the National Institute for Health and Care Excellence (NICE) self-harm guidelines (longer-term management) and also chaired the Quality Standards for self-harm. He is currently chairing the NICE guidelines for depression in adults. He is a member of the Department of Health's (England) National Suicide Prevention Strategy Advisory Group. The other authors declare no competing interests.

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