



Criminality and Suicide – A longitudinal Swedish Cohort Study

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Criminality and Suicide – A longitudinal Swedish Cohort Study

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ABSTRACT

Objectives: This study aimed to investigate whether both violent and non-violent offending was related to elevated risk of suicide mortality in a male cohort of 49,398 18-20 years young men during a 35-years period. We also investigated if the risk was higher among those with repeated offences and how experiences of substance abuse and suicide attempt modified the relationship.

Design: A cohort study with a longitudinal design.

Participants: The cohort comprises all young men conscripted for military service in 1969/70. Possible confounders were collected at the time of conscription through interviews and two questionnaires. The cohort has been matched with official registers measuring violent and non-violent criminality and suicide mortality from 1970 and onwards. Estimates of suicide risk were calculated as hazard ratio (HR) with 95% confidence intervals (CI) using Cox proportional regression analyses with adjustment for potential confounding by family, psychological and behavioural factors including alcohol and substance use and psychiatric disorders.

Results: In the whole cohort, 29.04% had at least one non-violent conviction and 4.7% violent conviction. Suicide by poisoning was most prevalent in the criminal groups, while hanging in the non-criminals. In the crude model, the violent offenders had nearly five times higher hazard (HR=4.80, 3.73-6.19) to die from suicide and non-violent criminals about two (HR=2.14, 1.79-2.56). In the fully adjusted model the hazards were still significant for suicide.

Conclusions: Having experiences of violent or non-violent criminality were associated with increased hazard of suicide mortality. Co-morbidity with alcohol and substance use and psychiatric disorders modified the risk, but were still significant for non-violent criminals. It is crucial to identify offenders and especially repeated offenders who also suffer from alcohol or substance misuse and psychiatric illness in clinical settings in order to prevent suicide mortality.

ARTICLE SUMMARY

Article focus

The aim of this cohort study was to analyse the association of violent and non-violent criminality and suicide mortality in a large population based cohort of 49,398 18-20 years Swedish male conscripts and followed these for 35 years. Early covariates were collected through two questionnaires and interviews regarding psychosocial conditions including alcohol and substance use. Criminality, suicide attempt and suicide mortality were collected through official registers.

Key messages

- Poisoning as a suicide method was most prevalent in the criminal groups, while hanging in the non-criminals.
- In Cox proportional regression analyses, the violent offenders had nearly five times higher hazard to die from suicide and non-violent criminals about two. After controlling for early covariates, the hazards still remained significant for suicide.
- Suicide attempt, severe alcohol and substance use measured at follow-up modified the risk of criminality on suicide.

Strengths and limitations of this study

- The study is based on a large national cohort with a longitudinal design and with several adolescent covariates. Only a small part 2-3 % of the participants was excluded from the study mainly because of physical or psychiatric handicap.
- This study adds knowledge about the association between violent and non-violent criminality and suicide mortality.
- The limitations were that non-anonymous questionnaires were used, which could have affected to a lower response rate of especially problematic issues such as alcohol and substance use.

INTRODUCTION

Almost one million people worldwide die from suicide every year[1]. Suicide was accounted for 1.8% of the total disease burden in 1998 and has been estimated to be 2.4% by 2020[2]. Further, suicide is one of the three leading causes of mortality in the age category 15-44 years and the second among those aged 15-19[3].

Earlier studies on the relationship between criminality and suicide mortality have been mostly conducted on populations in prison or newly released from prison[4]. These studies have found an elevated risk of 5 to 10 for suicide compared to the general population and more than a third of the suicide cases had a history of criminality among men[5-6].

Studies of suicide mortality among offenders who are not in prisons are rather few, but an elevated risk in this population has also been reported[7-8]. Webb et al examined various kinds of offences in a national population based study and found violent offences as the most important predictor for suicide with an odds ratio of nearly five and after adjustment for psychiatric admission, the odds decreased more than the double[6].

In a Swedish national cohort study of 992 881 young adults both female and male repeated offenders had a suicide risk of about six times higher than non-offenders (9). In the sub analyses controlled for psychiatric in-patient care and for substance abuse until the end of the follow-up, women had a risk of 3.7 and men had a risk of 3.0[9].

A suicide attempt has been considered as the strongest clinical predictor of the subsequent suicide. The suicide risk after an attempt is up to 40 times the expected rate[10], and lifetime prevalence suicide rates of suicide attempters with severe coexistent psychiatric disorder are even higher [11].

In a Swedish national register based study, it was found that patients who had attempted suicide by hanging evinced highest risk to commit suicide in one year after the attempt[12].

Studies on risk factors for suicide have stressed the importance of substance misuse for elevated mortality rates[13-14]. In most studies suicide mortality is far higher in substance users than the general population. For instance, Darke et al[15] found about one third of the substance misusers had experiences of suicide attempts. Suicide mortality among opioid misusers has been estimated to 14 times higher than the general population[10,16]. Further, one fifth or more of the suicide cases have substances presented in the blood[15].

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3 A previous study on the Swedish conscripts with a 13-years follow-up revealed that social and
4 behavioural factors and neurotic and personality disorder measured at conscription were most
5 significantly associated with high rate of suicide[17]. Likewise, in a recent longitudinal study of
6 the association between offenders and victims of violence and cause specific mortality found that
7 suicide carried a hazard of about two after adjustment for various psychosocial covariates[13].
8
9 In this representative, nationwide, general population study we followed 49,398 Swedish
10 conscripts during 35 years, in order to examine whether both violent and non-violent offending
11 were related to elevated risk of suicide mortality. We also investigated if the risk is higher among
12 those with repeated offences and how experiences of substance abuse and suicide attempt
13 modified the relationship.
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21 This study aimed to address three main research questions:

- 22 (1) Do conscripts with violent or non-violent criminality differ in respect to hazards of suicide
23 mortality?
 - 24 (2) Do suicide risk increase with repeated offences?
 - 25 (3) Do history of previous suicide attempt and/or serious substance and alcohol misuse modify the
26 relationship between violent and non-violent criminality on suicide mortality?
 - 27 (4) Do methods of suicide differ between the criminal groups?
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34 MATERIAL AND METHODS

35 Participants

36 This nationwide study is based on 49,398 18-20 years young Swedish men conscripted for
37 military service from 1 July 1969 to 30 June 1970 to 2004. About 2-3% was exempted from the
38 military service mainly because of a congenital psychiatric or physical disorder or severe
39 handicap. In order to get as homogenous group as possible according to age, we included 48411
40 conscripts born 1949 to 1950. Six per cent of the conscripts were born in 1949, 18 % in 1950 and
41 75 % in 1951. The mean age at the end of the follow-up was about 53 years of age for the
42 survivors.
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53 Measures

54 Measurement of crime

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3 Data from the national Crime Register were used to identify date, type, and number of criminal
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5 offenses. The Crime Register contains information on all convictions in Sweden from 1966 and
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7 onwards. Criminality was divided in three categories: no crime, violent crime and non-violent
8
9 crime. Violence was defined as: homicide, manslaughter and assault and non-violent crime all the
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11 other convictions. We also categorized the cohort according to number of crimes meaning for
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13 violent and non-violent offenders: (0, 1, and 2 or more violent crimes).
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18 **Measurement of potential confounders**

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20 Two non-anonymous questionnaires were used at the time of conscription. The first included
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22 questions about family and psychosocial background and health. The second about substance use
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24 including alcohol and drug use and sniffing of solvents. Studies have shown that the
25
26 questionnaires have been found to have sufficient validity for epidemiological studies[17-18]. The
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28 included variables were family, behavioural, and psychological and health conditions measured at
29
30 conscription.
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34 The selection of variables was based on earlier research[13,18-21] and other studies of risk factors
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36 for criminality and suicide mortality[9]. We included 11 covariates which have proved to be
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38 significant in the bivariate Cox proportional regression analysis.
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41 The covariates were: fathers' social class (social class III vs. I-II), and medication for nervous
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43 problems among parents or other members in the family (yes, at least one parent or family
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45 member vs. no) conduct problems at school (at least once vs. no), any prior contact with police
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47 and juvenile authorities (yes at least once vs. no), having taken medication for psychiatric
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49 disorder (at least once vs. no).The psychological variables, emotional control and intellectual
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51 capacity, were assessed by trained military psychologist who performed a structured interview
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53 with all conscripts. The psychologists combined questionnaire and interview data and the
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55 measures were assessed on a 5-point Likert scale. The ratings were regularly checked for
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3 interrater reliability, which was satisfactory[22]. If the psychologist discovered or the conscript
4 reported any psychiatric disorder, the subject was referred to a psychiatrist and an eventual
5 diagnosis was coded according to ICD-8[17, 22]. Details of this procedure and the validity of the
6 assessments have been described earlier[17, 23-24].
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14 The intelligence scores were based on four main intellectual and cognitive tests, measuring
15 verbal, logical-inductive, spatial, and technical and mechanical ability. The results of the tests
16 were aggregated in a 5-point summary score for overall intelligence, as described in detail by
17 Ståhlberg[25] and David et al[26]. These scale of intelligence capacity was scored 1=very bad;
18 2=bad; 3=moderate; 4=good; 5=very good and expressed as intelligence (1–3 vs. 4–5). Details of
19 this procedure and the validity of the assessments have been described by Otto[22].
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27 Problematic alcohol use was dichotomized (yes vs. no, with yes defined as one or more of
28 consumption of ≥ 210 g pure alcohol per week, having ever taken an ‘eye-opener’, being
29 intoxicated often, having been taken into custody for public drunkenness on at least one
30 occasion, and non-prescription drug (ever vs. never). Drug misuse was coded (yes vs. no), with
31 yes defined as used illicit drugs 10 times or more or any intravenous drug use.
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38 Additionally, we included three variables regarding hospitalizations (alcohol and drug misuse and
39 attempted suicide) during the follow-up period.
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45 The cohort was followed through official registers and was linked at Statistics Sweden via the
46 unique personal number for each individual, which thereafter was replaced with an individual
47 serial number making the data anonymous to the research group, after approval of Karolinska
48 Institute Research Ethics Committee (Dnr 2007/174-31, Dnr 2008/1086-31/5).
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52 53 54 55 56 **Measures of alcohol and drug misuse and suicide attempt** 57 58 59 60

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3 Data from the National Hospital Register were used to identify inpatient care with alcohol and
4 drug misuse according to ICD-8 and ICD-9 from 1987 and ICD-10 from 1997 onwards.

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7 The National Hospital Register includes details concerning inpatient care stays and days at
8 hospital and diagnoses, and has covered all public hospitals in Stockholm and Uppsala County
9 since 1972, 85% of all Swedish public inpatient care stays since 1983, and about 98–99% since
10 1987. The ICD classifications for hospitalization and mortality were: Drug misuse – ICD-8: 304
11 and 965.0; ICD-9: 304, 965A, 968F, 969G and 969H; and ICD-10: F11-12, F14, F15, F16, F18,
12 F19, O35.5, P04.4, T40.0–T40.3, T40.5–T40.9, T43.6, Z71.5, and X42. Alcohol misuse – ICD-8:
13 291, 303, 571.00, 571.01 and 980; ICD-9: 291, 303, 305A, 357F, 425F, 535D, 571A–571D and
14 980; and ICD-10: E24.4, F10, G31.2, G62.1, G72.1, I42.6, K29.2, K70, K86.0, O35.4, P04.3,
15 Q86.0, T51, X45, Y91, Z50.2 and Z71.4. Suicide attempt: ICD-8 and ICD-9: Determined suicide
16 attempt: E950-E959 and undetermined. E980-E989: ICD-10: Determined X60-X84 and
17 undetermined suicide: Y10-Y34.

31 **Suicide mortality**

32 Cause of Death Register provides mortality data and covers more than 99% of all deaths
33 occurring in Sweden and is based on information from death certificates. Suicide was classified
34 according to ICD-8 and ICD-9: E950-E959 and ICD-10: X60-X84 or as death with undetermined intent
35 ICD-8 and ICD-9: E980-E989 and ICD-10: Y10-Y34. The same ICD-codes as for the hospital register.

44 **Statistical analyses**

45 Cox proportional regression analysis was used to calculate hazard ratios (HRs) for early
46 covariates measured at conscription in relation to time to suicide mortality. The survival time was
47 calculated from September 1969 until time of death for those who died during 1969 (2 subjects)
48 and from 1 January 1970 until death or until 31 December 2004 for all other subjects in the
49 cohort.

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3 We had no exact information whether a person had emigrated from Sweden or not during the
4 follow-up period, while we could not censor for emigration in the calculation of person time. In
5 order to investigate the association between the quantity of criminal offences and mortality, we
6 categorized subjects according to committed numbers of offences (0, 1, 2 and more) in relation to
7 the time to suicide mortality by using Cox proportional regression analysis with 95 % confidence
8 intervals (95% CI). We adjusted for potential risk factors as described above. These were
9 measured at the time of conscription and only measured once why the time order was difficult to
10 prove. Some of these variables like alcohol- or substance use could act as confounders or
11 mediators on both criminality and suicide mortality.
12

13 A test of the proportional hazard assumption was performed for each covariate in bivariate and
14 multivariate analyses by using a time-dependent explanatory variable. If the p-value was
15 significant ($p < .05$) the proportional hazard assumption was violated and the variable was not
16 included in the analyses.
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18 We used Kaplan-Meier survival curves to plot survival probability of suicide mortality in non-
19 criminals, violence and other criminality during the 35 years follow-up.
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21 Chi-squared (X^2) test was used when calculating early covariates and hospitalization in relation to
22 criminality (Table 1).
23

24 **Sensitivity analysis**

25 We included different levels of numbers (0,1 and 2 or more) of both violent and non-violent
26 offences in both crude and multivariate regression analyses in relation to suicide mortality (Table
27 4).
28

29 **RESULTS**

30 Of the total cohort, 2,671 (5.5%) died during the follow-up period. Of these 615 (23.6%) died due to
31 suicide. The suicide cases were rather equally distributed during the follow-up. More than one third
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(34%) of the suicide cases were 30 years or younger, 31% were in the age category 31-40 years and the remaining subjects (36%) were 41 years or older. The mean age was 36 years.

Table 1 shows the distribution of 11 covariates divided into the three groups of criminals. All risk factors differed significantly ($p < 0.0001$) between the groups, but mostly contact with the police or juvenile authorities ($X^2 = 3305.72$, $p < 0.0001$) and having had conducted problems at school ($X^2 = 2470.41$, $p < 0.0001$). Regarding hospitalization of alcohol or drug misuse which had occurred during the follow-up period, alcohol misuse differed most significantly between the groups ($X^2 = 4464.28$, $p < 0.0001$).

A history of suicide attempts ($n = 1192$, 2.4%) was most common in violent offenders (13.5%) followed by other criminal offenders (4.1%) and lowest among non-offenders (0.9%) ($X^2 = 1647.76$, $p < 0.0001$).

Methods of suicide

Table 2 shows that the most common methods were intoxication and hanging, with significant risks between the groups ($p = 0.0006$ and $p = 0.0011$, respectively). Poisoning was most prevalent in the two criminal groups (67% in total), while hanging was most prevalent among the non-criminals (57.7%).

Crude and multivariate analyses

Violent related criminality was mostly associated with suicide (HR=4.69, 95%CI 3.56-6.19) followed by non-violent criminality (HR=2.08, 95%CI 1.72-2.52) in bivariate analyses, while after adjustment for the adolescent risk factors, the hazards decreased to nearly three and two fold respectively (Table 2). In the fully adjusted model we also included alcohol and drug inpatient care stays and suicide attempt and found elevated hazards, however only significant in non-violent offenders.

Repeated violent and non-violent offenders in relation to suicide mortality

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3 Both repeated non-violent and violent offences were associated with elevated hazards of suicide in
4 crude analyses (HR=3.27 and HR=5.40). When adjusted for early covariates the repeaters of both
5 violent and non-violent offenders decreased to HRs =2.42 and 2.34, respectively (Table 3).
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11 We conducted Kaplan-Meier survival distribution curves for the three criminal groups in relation
12 to suicide mortality from 1970 up to 2004. We found that violent criminality were associated with
13 lower survival than the other two criminal groups (violent and non-violent offenders and no
14 offenders) (Fig 1).
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20 21 22 **DISCUSSION**

23 This study aimed to analyse suicide mortality in three groups of criminals: non-criminal, violent
24 and non-violent criminal offenders. Very few earlier studies on the association between violent
25 and non-violent criminality and suicide have been conducted in a cohort representing the general
26 population and with a long follow-up period.
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36 Nearly one third of the death cases were due to suicide in those who had ever committed a violent
37 offence and one fourth in the non-violent group, which is in line with earlier studies reporting high
38 proportionate mortality (the percentage of the dead who died by suicide) among homicide
39 offenders and among personality-disordered offenders subject to forensic psychiatric assessment
40 [27-28]. Likewise, the survival for the violent criminals was lower than the other two groups.
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42 The fact that suicide and suicide attempt were more frequent in the criminal groups than non-
43 criminals could be an effect of both alcohol or other substance use but also psychiatric disorders or
44 other negative life circumstances[29].
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54 Somewhat surprisingly, poisoning as the method of completed suicide was more frequent in the
55 two criminal groups than in non-criminals, while hanging is the most common method among
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3 men in Sweden; however, to the best of our knowledge, no earlier studies have focused on the
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5 choice of suicide method in relation to criminality.
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8 In a study by Titelman et al[30] suicide by hanging or firearm was the most common methods in
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10 the Nordic countries. The aggressive methods were more common among men and poisoning
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12 among females. It has been argued that suicide attempts by poisoning have mostly non-fatal
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14 outcome because of lower dosages after the introduction of blister packaging and often being
15
16 rescued by accessible emergency care[31]. In this study we found that nearly half of those who
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18 had committed suicide had used poisoning as a method followed by hanging. However the
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20 criminals were more likely having used poisoning and a possible explanation to our finding is that
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22 alcohol and substance use was more common in the criminal groups. Even after analyses of
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24 suicides with intent and uncertain intent poisoning was still the most common method in this
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26 cohort and especially in the criminal groups.
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30 We found that violent offenders had nearly six times higher crude risk and non-violent offenders
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32 more than two-fold higher risk for suicide mortality at the age of 30 years or older. Even after
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34 controlling for multiple confounders the hazards remained significant. Alcohol and substance
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36 misuse and attempted suicide in the fully adjusted model were confounding on suicide, which
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38 imply a strong association between these clinical predictors and suicide risk.
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41 Suicide attempts had been experienced by 1192 (2.4%), which could be considered as rather low
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43 frequency when comparing with the completed suicides (n=615). Studies have indicated that
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45 suicide attempts are up to 20 times more frequent than completed suicide[1]. We had data on only
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47 suicide attempts needing inpatient care, namely serious suicide attempts, which could explain the
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49 ratio. We have no knowledge about attempted suicides that not turn up as hospital records. Some
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51 suicide attempters do not search help at any care givers[32-33].
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54 In our study, one of five suicide victims had attempted suicide, indicating a strong association
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56 between attempted and completed suicide. This was especially evident for violent offenders where
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3 one in three had experienced attempted suicide. Suicide attempt has been considered as one of the
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5 strongest predictors of suicide and the risk seem to be elevated up to older ages and during long
6
7 time periods (34). Additionally, factors as socioeconomic status and school performance are
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9 important factors for suicidal behavior and suicides[35-36].
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12 Further, the criminal offenders were more likely to have experiences of psychiatric diagnoses
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14 already at the age at 18 compared to no offenders. Alcohol misuse has also in other studies been
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16 pointed out as a severe risk factor for suicide and in some studies the second most common
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18 diagnostic group[37]. Wilcox et al[16] found alcohol misusers having a 10-fold increase risk for
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20 suicide in a mixed-age cohort. Likewise, in a longitudinal cohort study by Flensburg-Madsen et
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22 al[38] individuals with alcohol use disorders had eight times higher hazards of suicide compared
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24 to individuals with no alcohol use. The hazard fell to three after adjustment of psychiatric
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26 disorders. In the present study, about half of the violent offenders had reported either risky alcohol
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28 or substance use at the time of conscription. Whether alcohol leads to violence or vice versa seems
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30 to be unclear[39]. The fact that the suicide rate is somewhat higher in the violent criminals than
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32 non-violent criminals, one could assume that alcohol misuse play an important role for both
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34 violence and suicide[38].
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39 There is some evidence in the literature that violent criminals have higher rates of suicide, but
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41 these numbers are often derived from prison populations with often difficult circumstances such as
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43 overcrowded cells and spaces which contribute to psychiatric illness[40]. However, studies from
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45 Scotland and Wales found that the suicide rates are also unusually high among non-custody
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47 offenders when comparing to the general population[41-42].
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52 One possible explanation to our finding is that alcohol and substance use is more common in the
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54 criminal groups including fatal and non-fatal poisonings compared to non-criminals.
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3 The yearly incidence rates of suicide mortality have not shown a clear decrease as other cause of
4 deaths in the younger age categories in Sweden, why it is important to identify delinquency at
5 young ages and other related risk factors in order to find preventive strategies for this group[6].
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9 There are evidence that suicide rates are high also in the older ages, often due to loneliness,
10 anxiety disorder and depression[43]. This in turn indicates the importance of early detection and
11 prevention strategies and treatment for substance users and especially those with suicidal
12 tendencies[37].
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Psychiatric disorders have been shown to be correlated to both violence and suicide. King and
Barraclough[44] found 27 times higher risk of unnatural death (suicide, accident and
undetermined) among individuals who had recently been in contact with psychiatric clinics
compare to those who had not. Likewise, persons with psychiatric illness as schizophrenia are
more likely to die due to suicide[45]. Further, suicide attempt has been considered as one of the
strongest predictors of suicide and the risk seem to be elevated up to older ages and during long
time periods[34].

Advantages and limitations

An advantage of this study is the large national cohort with a longitudinal design and with several
adolescent covariates. Only a small part 2-3 % of the conscripts was excluded from the study
mainly because of physical or psychiatric handicap. The two questionnaires used at conscription
were non-anonymous, which could have affected to a lower response rate of especially
problematic issues such as alcohol and substance use. However, other studies on conscription
cohort have compared register and self-reported information of alcohol and substance use and
found good agreement between the different sources of data[23]. A small number of the conscripts
missed one or some of the items in the questionnaires (Table 1). That was especially evident for
those subjects who had committed violent offences whereas the response rate for the covariates

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3 included in the study varied from 0.26 to 9.45%. The corresponding measures for other criminality
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5 and non-criminals were: 0.20 to 6.37% and 0.13 to 4.19%. The violent offenders had probably
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7 more severe risk factors than the non-violent and non-criminal groups which could have resulting
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9 in underestimating of the hazards of suicide. One could assume that these subjects also had higher
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11 rates of substance use and other maladjusted behaviour measured at conscription which in turn
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13 could have affected the outcome[46]. However, we have no reason to believe that the risk for the
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15 outcome, suicide mortality, has been considerable affected due the internal missing data.
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17 Another limitation of this study is that we do not have information about criminality not turning
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19 up in the register. Some subjects could have committed many violent and non-violent crimes,
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21 especially in combination with substance misuse, and never been convicted of a crime.
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27 **Conclusions**

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29 We found that individuals registered for either violent or other criminality are at increased risk for
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31 committing suicide and that is especially evident for those who were criminal repeaters. The two
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33 criminal groups were more likely to commit suicide by poisoning indicating prior experiences of
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35 substance misuse. Hanging was most common in the non-criminal group which has been shown to
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37 be the most common method in Sweden[12]. We suggest that authorities and the health care
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39 should evaluate both violent and non-violent criminals and especially those with combination of
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41 alcohol and substance misuse for suicide risk.
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47 **Acknowledgements**

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50
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54
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3 **Contributors:** MS planned the study, conducted the statistical analyses and wrote the final
4 version of the manuscript. AS contributed to the planning and data analyses. JJ and AR
5 contributed to the planning of the study and preparing of the manuscript. All authors contributed
6 to the final draft of the manuscript.
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16 **Ethics approval:** .Karolinska Institute Research Ethics Committee (Dnr 2007/174-31, Dnr
17 2008/1086-31/5).
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Table 1. Risk factors measured at conscription and hospitalization in relation to non-violent and violent criminality				
	No crime	Non-violent criminality	Violent criminality	Chisq, prob.**)
Fathers' social class				
III	47.67	50.38	58.07	
1-II	48.43	43.24	32.48	204.72, p<0.0001
Missing *)	3.90	6.37	9.45	
Medication for nervous problems in the family				
Yes (parents or other family members)	30.11	34.53	40.35	
No	67.02	61.61	54.11	201.34, p<0.0001
Missing	2.88	3.86	5.54	
Conduct problems at school				
Yes (at least once)	17.69	33.44	52.22	
No	81.39	65.05	45.45	2470.41, p<0.0001
Missing	0.92	1.51	2.33	
Own medication for psychiatric problems				
Yes	9.94	18.58	4.56	
No	89.02	85.22	77.23	293.35, p<0.0001
Missing	1.04	1.68	2.73	
Emotional control				
Very bad, bad	26.8	34.84	49.89	
Very good, good, medium	72.6	64.12	48.22	769.81, p<0.0001
Missing	0.70	1.04	1.89	
IQ				
Below average	16.03	23.24	35.69	
Above average, average	83.84	76.56	64.04	764.81, p<0.0001
Missing	0.13	0.20	0.26	
Psychiatric diagnosis (at conscription)				
Yes (at least one diagnosis)	9.73	15.87	29.85	
No	88.58	82.06	68.53	1008.59, p<0.0001
Missing	1.69	2.07	1.63	
Contact with police and juvenile authorities				
Yes (several or some times)	20.77	39.38	64.09	

No	77.86	58.62	33.14	3305.72, p<0.0001
Missing	1.37	2.00	2.77	
Risky alcohol use				
Yes	8.29	19.79	39.60	
No	90.43	78.40	57.58	2681.86, p<0.0001
Missing	1.28	1.81	2.91	
Dug misuse				
Yes	1.81	6.49	10.94	
No	94.00	88.53	82.22	1022, 23, p<0.0001
Missing	4.19	4.97	6.84	
Sniffing				
At least once	9.84	18.43	29.58	
No	88.82	79.38	66.81	1234.54, p<0.0001
Missing	1.34	2.19	3.60	
Hospitalization				
Alcohol hospitalization				
Yes (at least once)	1.76	10.75	31.96	
No	98.24	89.25	68.04	4464.28, p<.00001
Drug use hospitalization				
Yes (at least once)	0.15	2.48	11.65	
No	99.85	97.52	88.35	2269.25, p<.00001
Hospitalization for suicide attempts				
Yes (at least once)	0.94	4.10	13.54	
No	99.06	95.90	86.46	1647.76, p<0.0001

*)No answers were given to this item

**) p-value calculated for non-missing observations

Table 2. Distribution of methods of suicide in conscripts divided in three criminal groups					
Methods of suicide		No crime	Non-violent criminality	Violent criminality	Chisq, p-value
		%	%	%	
Poisoning E950-E952, E980-E982, X60-X69, Y10-Y19	Yes (n=278, 45%)	36.33	46.40	17.27	14.72, P=0.0006
	No (n=337, 55%)	51.63	36.50	11.87	
Hanging/suffocation: E953, E983, X70, Y20	Yes (n=149, 24%)	57.72	32.21	10.07	13.59, P=0.0011
	No (n=466, 76%)	40.56	43.78	15.67	
Firearm: E955, E985, X722-X74, Y422-Y424	Yes (n=69, 11.2%)	55.07	33.33	11.59	3.37, P=0.1852
	No (n=546, 88.8%)	55.07	33.33	11.59	
Drowning: E954, E984, X71, Y21	Yes (n=41, 7%)	44.43	41.46	14.11	0.897, P=0.6386
	No (n=574, 93%)	48.78	34.15	17.07	
Jump from heights: E957, E987, X80, Y30	Yes (n=27, .39%)	37.04	51.85	11.11	1.38, P=0.4992
	No (588, 5.61%)	45.07	40.08	14.46	
Train movement: E9580, E9880, X81, Y31	Yes (n=22, 3.58%)	44.69	40.98	14.33	0.010, P=0.9950
	No(n=593, 96.42%)	45.45	40.91	13.65	
Cutting: E956, E986, X79, Y28	Yes (n=16, 2.6%)	31.25	62.50	6.25	3.27, P=0.1950
	No (=599, 97.4%)	45.08	40.40	14.52	
Others: E958-959, E988-989, X75-X77, X79, X82-X84, Y425-Y27, Y29, Y32-Y34	Yes (n=13, 2.11%)	38.46	38.46	23.08	0.85, P=0.6537
	No (n=602, 97.89%)	44.85	41.03	14.12	

Table 3. Criminality in relation to suicide mortality adjusted for early risk factors measured at conscription ¹⁾ and in addition adjusted for alcohol and drug inpatient and suicide attempt ²⁾.

Suicide N=615					
Criminality	No. of exposed	No. of cases	HR Crude	HR Adjusted ¹⁾	HR Adjusted ²⁾
Never	32376	275	1.0	1.0	1.0
Non-violent	14183	252	2.08, 1.72-2.52	1.65, 1.35- 2.01	1.35, 1.10- 1.67
Violent	2275	88	4.69, 3.56-6.19	2.68, 1.98-3.64	1.30, 0.92-1.82

¹⁾ adjusted for fathers' social class, medication for nervous problems in the family, conduct problems at school, own medication for psychiatric disorder, contact with police and juvenile authorities, emotional control, intellectual capacity, psychiatric diagnosis at conscription, sniffing of solvents, risky alcohol misuse and substance misuse.

²⁾ In addition adjusted for alcohol and drug inpatient and suicide attempt.

Table 4. Number of offences adjusted for early risk factors at conscription ¹⁾ and in addition for alcohol and drug inpatient and suicide attempt ²⁾.

Suicide N=615			
Criminality	HR Crude	HR Adjusted ¹⁾	HR Adjusted ²⁾
Non-violent offence			
0 offence (n=32376, 66.30%)	1.0	1.0	1.0
1 offence (n=7322, 14.99%)	1.46, 1.15-1.85	1.25, 0.96-1.63	1.18, 0.91-1.55
2+ offences (n=9136, 18.71%)	3.27, 2.75-3.88	2.24, 1.81-2.77	1.49, 1.17-1.89
Violent offence			
0 offence (n=46559, 95.34%)	1.0	1.0	1.0
1 offence (n=1556, 3.19%)	2.65, 1.96-3.58	1.83, 1.29-2.59	1.17, 0.82-1.67
2+ offence (n=719, 1.47%)	5.40, 3.94-7.39	2.42, 1.61-2.59	0.84, 0.54-1.31

¹⁾ adjusted for fathers' social class, medication for nervous problems in the family, conduct problems at school, own medication for psychiatric disorder, contact with police and juvenile authorities, emotional control, intellectual capacity, psychiatric diagnosis at conscription, sniffing of solvents, risky alcohol misuse and substance misuse.

²⁾ In addition adjusted for alcohol and drug inpatient and suicide attempt.

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of cohort studies

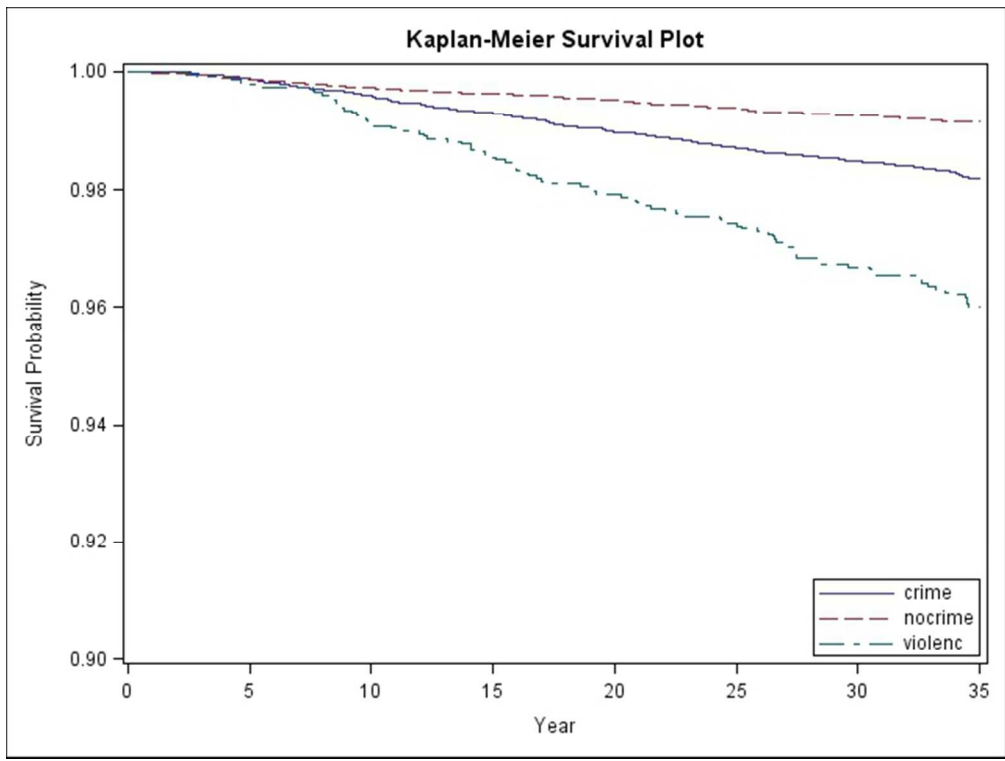
Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study’s design with a commonly used term in the title or the abstract	1
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	5
		(b) For matched studies, give matching criteria and number of exposed and unexposed	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6-8
Bias	9	Describe any efforts to address potential sources of bias	5,14
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	8
		(b) Describe any methods used to examine subgroups and interactions	8-9
		(c) Explain how missing data were addressed	14-15,22
		(d) If applicable, explain how loss to follow-up was addressed	8-9
		(e) Describe any sensitivity analyses	9
Results			14-15

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed (b) Give reasons for non-participation at each stage (c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (b) Indicate number of participants with missing data for each variable of interest (c) Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	Report numbers of outcome events or summary measures over time	8-9
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	9-11, 22-26
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	11
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	11-14
Generalisability	21	Discuss the generalisability (external validity) of the study results	
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	11

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

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

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Criminality and Suicide – A longitudinal Swedish Cohort Study

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Criminality and Suicide—A longitudinal Swedish Cohort Study

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Keywords: criminality, risk factors, substance use, violence, suicide

Word count: 3698

ABSTRACT

Objectives: This study aimed to investigate whether both violent and non-violent offending was related to elevated risk of suicide in a male cohort of 49,398 18-20 years young men during a 35-years period. We also investigated if the risk was higher among those with repeated offences and how experiences of substance abuse and suicide attempt modified the relationship.

Design: A cohort study with a longitudinal design.

Participants: Possible confounders were obtained from a nationally representative birth cohort of 49,398 18-20 years young men who were mandatory conscripted for military service in 1969/70. The cohort has been linked to mortality and hospitalization and crime records from 1970 and onwards. Estimates of suicide risk were calculated as hazard ratio (HR) with 95% confidence intervals (CI) using Cox proportional regression analyses with adjustment for potential confounding by family, psychological and behavioural factors including alcohol and substance use and psychiatric disorders.

Results: In the whole cohort, 29.04% had at least one non-violent and 4.7% violent conviction. Suicide by poisoning was most prevalent in the criminal groups, while hanging in the non-criminals. In the crude model, the violent offenders had nearly five times higher risk (HR=4.80, 3.73-6.19) to die from suicide and non-violent criminals about two (HR=2.14, 1.79-2.56). In the fully adjusted model the hazard ratios were still significant for suicide.

Conclusions: Having experiences of violent or non-violent criminality were associated with increased risk of suicide. Co-morbidity with alcohol and substance use and psychiatric disorders modified the risk, but were still significant for non-violent criminals. It is crucial to identify offenders and especially repeated offenders who also suffer from alcohol or substance misuse and psychiatric illness in clinical settings in order to prevent suicide.

ARTICLE SUMMARY

Article focus

The aim of this cohort study was to analyse the association between violent and non-violent criminality and suicide in a large population based cohort of 49,398 18-20 years Swedish male conscripts followed-up for 35 years. Early confounders were collected through two questionnaires and interviews regarding psychosocial conditions including alcohol and substance use.

Criminality, suicide attempt and suicide data were collected through official registers.

Key messages

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- In Cox proportional regression analyses, the violent offenders had nearly five times higher hazard ratio to die from suicide and non-violent criminals about two. After controlling for early covariates, the hazard ratios still remained significant for suicide.
- Suicide attempt, severe alcohol and substance use measured at follow-up modified the risk of criminality on suicide.
- Poisoning as a suicide method was most prevalent in the criminal groups, while hanging in the non-criminals.

Strengths and limitations of this study

- The study is based on a large national cohort with a longitudinal design and with several adolescent confounders. Only a small part 2-3 % of the participants was excluded from the study mainly because of physical or psychiatric disorder/disability.
- This study adds knowledge about the association between violent and non-violent criminality and the risk of suicide.
- The limitations were that non-anonymous questionnaires were used, which have contributed to a lower response rate of especially problematic issues such as alcohol and substance use, but the response rate was nevertheless high.

INTRODUCTION

Almost one million people worldwide die from suicide every year. Suicide was accounted for 1.8% of the total disease burden in 1998 and has been estimated to be 2.4% by 2020.[1] Further, suicide is one of the three leading causes of mortality in the age category 15-44 years and the second among those aged 15-19.[2]

Earlier studies on the relationship between criminality and suicide have been mostly conducted on populations in prison or newly released from prison.[3-6] Studies have found an elevated risk of 5 to 9 and in some studies much higher depending on the age group for suicide among prison inmates compared to the general population and more than a third of the suicide cases had a history of criminality among men.[5-6]

Studies of suicide among offenders who are not in prisons are rather few, but an elevated risk in this population has also been reported.[7-8] Webb et al. examined various kinds of offences in a national population based study and found violent offences as the most important predictor for suicide with an odds ratio of nearly five and after adjustment for psychiatric admission, the odds decreased more than the double.[5]

In a Swedish national cohort study of 992 881 young adults both female and male repeated offenders had a suicide risk of about six times higher than non-offenders [9]. In the sub analyses controlled for psychiatric in-patient care and for substance abuse until the end of the follow-up, women had a risk of 3.7 and men had a risk of 3.0.[9]

A suicide attempt has been considered as the strongest clinical predictor of the subsequent suicide. The suicide risk after an attempt was up to 40 times the expected rate.[10] and lifetime prevalence suicide rates of suicide attempters with severe coexistent psychiatric disorder were even higher. [11]

In a Swedish national register based study, it was found that patients who had attempted suicide by hanging evinced highest risk to commit suicide in one year after the attempt.[12]

Studies on risk factors for suicide have stressed the importance of substance misuse for elevated mortality rates.[13-14] In most studies suicide is far higher in substance users than in the general population. For instance, Darke et al.[15] found about one third of the substance misusers had experiences of suicide attempts. Suicide among opioid misusers has been estimated to 14 times higher than the general population.[10,16] Further, one fifth or more of the suicide cases have substances presented in the blood.[15]

A previous study on the Swedish conscripts with a 13-years follow-up revealed that social and behavioural factors and neurotic and personality disorder measured at conscription were most

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3 significantly associated with high rate of suicide.[17] Likewise, in a recent longitudinal study of
4 the association between offenders and victims of violence and cause specific mortality found that
5 suicide carried a hazard ratio of about two after adjustment for various psychosocial confounders.
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7 [13]

8
9 In this representative, nationwide, general population study we followed 49,398 Swedish
10 conscripts during 35 years, in order to examine whether both violent and non-violent offending
11 were related to elevated risk of suicide. We also investigated if the risk is higher among those with
12 repeated offences and how substance abuse and suicide attempt history modified the relationship.
13 Moreover, we studied the choice of suicide methods for the violent and non-violent criminal
14 groups.
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21 This study aimed to address four main research questions:

22 (1) Do conscripts with violent or non-violent criminality differ in respect to hazard ratio of
23 suicide?
24

25 (2) Does suicide risk increase with repeated offences?
26

27 (3) Does history of previous suicide attempt and/or serious substance and alcohol misuse modify
28 the relationship between violent and non-violent criminality on suicide?
29

30 (4) Do methods of suicide risks differ between the criminal groups?
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33

34 MATERIAL AND METHODS

35 Participants

36 This nationwide study is based on 49,398 18-20 years young Swedish men conscripted for
37 military service from 1 July 1969 to 30 June 1970 to 2004. About 2-3% was exempted from the
38 military service mainly because of a physical or psychiatric disorder/disability. In order to get a
39 homogenous age group we included 48,411 conscripts born 1949 to 1950. Six per cent of the
40 conscripts were born in 1949, 18 % in 1950 and 75 % in 1951. The mean age at the end of the
41 follow-up was about 53 years of age for the survivors.
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51 Measures

52 Measurement of potential confounders

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3 At conscription, each conscript was asked to answer two non-anonymous voluntary
4 questionnaires. The first included questions about family and psychosocial background and
5 health. The second about substance use including alcohol and drug use and sniffing of solvents.
6
7 Studies have shown that the questionnaires have been found to have sufficient validity for
8 epidemiological studies[17-18].
9

10
11 Besides the measures of substance use, the confounders were selected from the conscription data,
12 based on the scientific studies and earlier studies of this cohort.[9,13,18-21] We included
13 11 confounders which have proved to be significant in the bivariate Cox proportional regression
14 analysis.
15

16
17 The confounders were: Fathers' social class (social class III vs. I-II). Medication for nervous
18 problems among parents or other members in the family (yes, at least one parent or family
19 member vs. no). Conduct problems at school (at least once vs. no). Any prior contact with police
20 and juvenile authorities (yes at least once vs. no). Having taken medication for psychiatric
21 disorder (at least once vs. no).
22

23
24 The psychological variables were: Emotional control and intellectual ability were assessed by
25 trained military psychologist who performed a structured interview with all conscripts. The
26 psychologists used both questionnaire and interview data and the measures were assessed on a 5-
27 point Likert scale. The ratings were regularly checked for interrater reliability, which was
28 satisfactory.[22] If the psychologist discovered or the conscript reported any psychiatric disorder,
29 the subject was referred to a psychiatrist and an eventual diagnosis was coded according to ICD-
30 8.[17, 22] Details of this procedure and the validity of the assessments have been described
31 earlier.[17, 23-24]
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33
34 Intellectual ability (IQ) was based on four main intellectual and cognitive tests, measuring verbal,
35 logical-inductive, spatial, and technical and mechanical ability. The results of the tests were
36 aggregated in a 5-point summary score for overall intelligence, as described in detail by
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3 Ståhlberg[25] and David et al.[26] These scale of intelligence capacity was scored 1=very bad;
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5 2=bad; 3=moderate; 4=good; 5=very good and expressed as intelligence (1–3 vs. 4–5). Details of
6
7 this procedure and the validity of the assessments have been described by Otto.[22]

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10 Problematic alcohol use was dichotomized (yes vs. no, with yes defined as one or more of
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12 consumption of ≥ 210 g pure alcohol per week, having ever taken an ‘eye-opener’, being
13
14 intoxicated often, having been taken into custody for public drunkenness on at least one
15
16 occasion, and non-prescription drug (ever vs. never). Drug misuse was coded (yes vs. no), with
17
18 yes defined as used illicit drugs 10 times or more or any intravenous drug use.
19

20 21 **Measures of alcohol and drug misuse and suicide attempt**

22
23 Data from the National Swedish inpatient register were used to identify inpatient care with alcohol
24
25 and drug misuse according to ICD-8 and ICD-9 from 1987 and ICD-10 from 1997 onwards.

26
27 The register includes details concerning inpatient care stays and days at hospital and diagnoses,
28
29 and has covered all public hospitals in Stockholm and Uppsala County since 1972, 85% of all
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31 Swedish public inpatient care stays since 1983, and about 98–99% since 1987. The ICD
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33 classifications for hospitalization and mortality were: Drug misuse – ICD-8: 304 and 965.0; ICD-
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35 9: 304, 965A, 968F, 969G and 969H; and ICD-10: F11-12, F14, F15, F16, F18, F19, O35.5,
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37 P04.4, T40.0–T40.3, T40.5–T40.9, T43.6, Z71.5, and X42. Alcohol misuse – ICD-8: 291, 303,
38
39 571.00, 571.01 and 980; ICD-9: 291, 303, 305A, 357F, 425F, 535D, 571A–571D and 980; and
40
41 ICD-10: E24.4, F10, G31.2, G62.1, G72.1, I42.6, K29.2, K70, K86.0, O35.4, P04.3, Q86.0, T51,
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43 X45, Y91, Z50.2 and Z71.4. Suicide attempt: ICD-8 and ICD- 9: Determined suicide attempt:
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45 E950-E959 and undetermined E980-E989; ICD-10: Determined X60-X84 and undetermined
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47 suicide attempt: Y10-Y34.
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50 51 **Suicide**

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53 Cause of Death Register provides mortality data and covers more than 99% of all deaths
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55 occurring in Sweden and is based on information from death certificates. Suicide was classified
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3 according to ICD-8 and ICD-9: E950-E959 and ICD-10: X60-X84 or as death with undetermined
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5 intent ICD-8 and ICD-9: E980-E989 and ICD-10: Y10-Y34. The same ICD-codes as for the
6
7 hospital register.
8

9 10 **Measurement of crime**

11 Data from the National Crime Register were used to identify date, type, and number of criminal
12
13 offenses. The Crime Register contains information on all convictions in Sweden from 1966 and
14
15 onwards. Criminality was divided in three categories: no crime, violent crime and non-violent
16
17 crime. Violence was defined as: homicide, manslaughter and assault and non-violent crime all the
18
19 other convictions. We also categorized the cohort according to number of crimes meaning for
20
21 violent and non-violent offenders: (0, 1, and 2 or more crimes).
22
23

24 The data was linked at Statistics Sweden (Statistiska Centralbyrån) via the unique personal
25
26 number for each individual, which thereafter was replaced with an individual serial number
27
28 making the data anonymous to the research group, after approval of Karolinska Institute.
29
30

31 32 **Statistical analyses**

33 Cox proportional bivariate and multivariate regression analysis was used to calculate hazard ratios
34
35 (HRs) with 95% confidence intervals (95% CI) for violent and non-violent criminality and
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37 suicide. We adjusted for early confounders measured at conscription in relation to time to
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39 suicide. The survival time was calculated from September 1969 until time of death for those who
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41 died during 1969 (2 subjects) and from 1 January 1970 until death or until 31 December 2004 for
42
43 all other subjects in the cohort.
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46 We had no exact information whether a person had emigrated from Sweden or not during the
47
48 follow-up period, therefore we could not censor for emigration in the calculation of person time.
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51 In order to investigate the association between the number of criminal offences and mortality, we
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53 categorized subjects according to committed numbers of offences (0, 1, 2 and more) in relation to
54
55 the time to suicide by using Cox proportional regression analysis. We adjusted for potential risk
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3 factors as described above. These were measured at the time of conscription and only measured
4
5 once why the time order was difficult to prove. Some of these variables like alcohol- or substance
6
7 use could act as confounders or mediators on both criminality and suicide.
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10 A test of the proportional hazard assumption was performed for each confounder in bivariate and
11
12 multivariate analyses by using a time-dependent explanatory variable. If the p-value was
13
14 significant ($p < .05$) the proportional hazard assumption was violated and the variable was not
15
16 included in the analyses.
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19 We used Kaplan-Meier survival curves to plot survival probability of suicide in non-criminals,
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21 violence and other criminality during the 35 years follow-up.
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24 Chi-square (X^2) test was used when calculating early confounders and hospitalization in relation
25
26 to criminality.
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28 29 **RESULTS**

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31 Of the total cohort, 2,671 (5.5%) died during the follow-up period. Of these 615 (23.6%) died due to
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33 suicide (474 determined and 141 undetermined). Suicide was prevalent in the criminal groups: no
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35 criminality (4.11%), non-violent (7.25%) and violent criminality (13.67%).
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39 The suicide cases were rather equally distributed throughout the 35 years follow-up period.

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41 More than one third (34%) of the suicide cases were 30 years or younger, 30% were in the age
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43 category 31-40 years and the remaining subjects (36%) were 41 years or older. The mean age was 36
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45 years.
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48 Table 1 shows the distribution of 11 confounders measured at conscription divided into the three
49
50 groups of criminals. All risk factors differed significantly ($p < 0.0001$) between the groups, but mostly
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52 contact with the police or juvenile authorities, and having had conducted problems at school.
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55 Regarding hospitalization of alcohol or drug misuse which had occurred during the follow-up period,
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57 alcohol misuse differed most significantly between the groups.
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Methods of suicide

Poisoning was the most prevalent method of suicide (n=278) followed by hanging and suffocation (n=149) (Table 2). The violent offenders had nearly seven times higher hazard to die from poisoning (HR=6.92, 95%CI 4.91-9.76), while the non-criminal group had twice lower risk (HR=2.94, 95%CI 2.26-3.81). The violent group had three times higher hazard ratio to die due to shooting by firearm, while the non-violent group had no significant risk.

Crude and multivariate analyses

Violent related criminality was mostly associated with suicide (HR=4.69, 95%CI 3.56-6.19) followed by non-violent criminality (HR=2.08, 95%CI 1.72-2.52) in bivariate analyses, while after adjustment for multiple confounders, the hazard ratios decreased to nearly three and two fold respectively (Table 3). In the fully adjusted model we also included alcohol and drug inpatient care stays and suicide attempt and found elevated hazard ratios, however, only significant in non-violent offenders.

Repeated violent and non-violent offenders in relation to suicide

Both repeated non-violent and violent offences were associated with elevated hazard ratios of suicide in crude analyses (HR=3.27 and HR=5.40). When adjusted for early confounders the repeaters of both violent and non-violent offenders decreased to HRs=2.42 and 2.34, respectively (Table 4).

We conducted Kaplan-Meier survival distribution curves for the three criminal groups in relation to suicide from 1970 up to 2004. We found that violent criminality was associated with lower survival (Fig 1).

DISCUSSION

This study aimed to analyse suicide in three groups concerning criminal offences: non-criminal, violent and non-violent criminal offenders.

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3 We found that nearly one third of the death cases were due to suicide in those who had ever
4 committed a violent offence and one fourth in the non-violent group, which is in line with earlier
5 studies reporting high proportionate mortality (the percentage of the dead who died by suicide)
6 among homicide offenders and among personality-disordered offenders subject to forensic
7 psychiatric assessment.[27-29]
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14 The main finding was that violent offenders had nearly five times higher crude risk and non-
15 violent offenders more than two-fold higher risk for suicide compared to no criminals. Even after
16 controlling for multiple confounders measured at conscription the hazard ratios remained
17 significant. Alcohol and substance misuse and attempted suicide in the fully adjusted model were
18 confounding on suicide remaining barely significant or non-significant risk for suicide. This imply
19 a strong association between these clinical predictors and suicide risk.[11,30] However, we do not
20 have knowledge about the time order between criminality and the clinical factors measured during
21 the follow-up period, why we have to take the results with cautions.
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32 We found that poisoning as method of completed suicide was most prevalent in violent and non-
33 violent criminals, while hanging was the most prevalent method among non-criminals. That was
34 also the case for men in the whole of Sweden.[31] In a Danish national register study of 9708
35 suicide cases and 188,134 age and gender matched living controls, hanging was the leading
36 suicide method among men, while poisoning among women.[32-33] One possible explanation to
37 the high prevalence of poisoning in criminals in our study could be that alcohol and substance use
38 was more prevalent in the criminal groups including fatal and non-fatal poisonings compared to
39 non-criminals.
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52 There is some evidence in the literature that violent criminals have higher rates of suicide, but
53 these numbers are often derived from prison populations with often difficult circumstances such as
54 overcrowded cells and spaces which may contribute to psychiatric illness.[34] Very few earlier
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3 studies on the association between violent and non-violent criminality and suicide have been
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5 conducted in a cohort representing the general population and with a long follow-up period.

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7 However, national data from England and Wales found after age standardization, 9- to 13-fold
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9 increased risk for suicide in both prisoners and non-custody offenders.[34]

10
11 The yearly incidence rates of suicide have not shown a clear decrease in the younger age
12
13 categories in Sweden, why it is important to identify delinquency at young ages and other risk
14
15 factors in order to find preventive strategies for this group.[5] Generally, suicide rates are higher
16
17 among the older age groups, often due to loneliness, anxiety disorder and depression.[35-36] In
18
19 this study, the suicide cases were rather equally distributed throughout the 35 years follow-up
20
21 period which probably means that all age categories seem to be vulnerable for suicide.
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23

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25 It has been argued that suicide attempts by poisoning nowadays have mostly non-fatal outcome
26
27 because of lower dosages after the introduction of blister packaging and often being rescued by
28
29 accessible emergency care [37-38], indicating the importance of analysing both licit and illicit
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31 drugs involving in suicide. As mentioned above the criminal groups are more likely to use illicit
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33 drugs and additionally alcohol and prescribed drugs.[11, 35]

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35
36 Suicide attempts had been experienced by 1192 men (2.4%), which could be considered as rather
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38 low frequency when comparing with the completed suicides (n=615). An American national
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40 study (National Survey on Drug Use and Health), based on interviews and web-questionnaires
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42 from 92,264 respondents in year 2008 and 2009, found one suicide case for every 25 attempted
43
44 suicides.[39] We had data on only suicide attempts needing inpatient care, namely serious suicide
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46 attempts, which could explain the ratio. We did not have data on attempted suicides that not turn
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48 up as hospital records. Some suicide attempters do not search help at any care givers.[40-41]. In
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50 our study, one out of five suicide victims had attempted suicide, confirming a strong association
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52 between attempted and completed suicide. This was especially evident for violent offenders where
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54 one in three had experienced attempted suicide. Suicide attempt has been considered as one of the
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3 strongest predictors of suicide and the risk seem to be elevated up to older ages and during long
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5 time periods.[42] Alcohol misuse has also in other studies been pointed out as a severe risk factor
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7 for suicide and in some studies the second most common diagnostic group.[35,43]. Wilcox et
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9 al.[16] found alcohol misusers having a 10-fold increase risk for suicide in a mixed-age cohort.
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11 Likewise, in a longitudinal cohort study by Flensburg-Madsen et al.,[44] individuals with alcohol
12
13 use disorders had eight times higher hazard ratios of suicide compared to individuals with no
14
15 alcohol use. The hazard ratio fell to three after adjustment of psychiatric disorders. These findings
16
17 indicate the importance of early detection and prevention strategies and treatment for substance
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19 users and especially those with suicidal tendencies in all ages.[36] In the present study, about half
20
21 of the violent offenders had reported either risky alcohol or substance use at the time of
22
23 conscription and nearly one third had been treated at hospital for an alcohol related diagnosis. The
24
25 relationship between alcohol use and violence seems to be complex.[45] The fact that the suicide
26
27 rate is somewhat higher in the violent criminals than non-violent criminals, one could assume that
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29 alcohol misuse play an important role for both violence and suicide [43].
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34 We found that one third of the violent offenders were already diagnosed at conscription with a
35
36 psychiatric diagnosis. Psychiatric disorders are strongly related to suicide risk, whereas the
37
38 association between mental illness and violent crime is not as evident. King and Barraclough[45]
39
40 found 27 times higher risk of unnatural death (suicide, accident and undetermined) among
41
42 individuals who had recently been in contact with psychiatric clinics compare to those who had
43
44 not. Persons with severe psychiatric disorders like affective disorder and schizophrenia have
45
46 highly elevated lifetime suicide risk.[46-47]
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48

49 **Advantages and limitations**

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51 An advantage of this study is the large national cohort with a longitudinal design and with several
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53 adolescent covariates. Only a small part 2-3 % of the conscripts was excluded from the study
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55 mainly because of physical or psychiatric disorders. The two questionnaires used at conscription
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3 were non-anonymous, which could have contributed to a lower response rate of especially
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5 problematic issues such as alcohol and substance use. However, other studies on conscription
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7 cohort have compared register and self-reported information of alcohol and substance use and
8
9 found good agreement between the different sources of data [23]. A small number of the
10
11 conscripts missed one or some of the items in the questionnaires. That was especially evident for
12
13 those subjects who had committed violent offences whereas the response rate for the confounders
14
15 included in the study varied from 0.26 to 9.45%. The corresponding measures for other criminality
16
17 and non-criminals were: 0.20 to 6.37% and 0.13 to 4.19%. The violent offenders had probably
18
19 more severe risk factors than the non-violent and non-criminal groups which could have resulting
20
21 in underestimating of the hazard ratios of suicide. One could assume that these subjects also had
22
23 higher rates of substance use and other maladjusted behaviour measured at conscription which in
24
25 turn could have affected the outcome.[48] However, we have no reason to believe that the risk for
26
27 the outcome, suicide, has been considerable affected due the internal missing data.
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31 Another limitation of this study is that we do not have information about criminality not turning
32
33 up in the register. Some subjects could have committed many violent and non-violent crimes,
34
35 especially in combination with substance misuse, and never been convicted of a crime.
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37

38 **Conclusions**

39
40 We found that individuals registered for either violent or other criminality are at increased risk for
41
42 committing suicide in crude analysis and that is especially evident for those who were criminal
43
44 repeaters. However, after adjusting for confounders measured at conscription the risk was still
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46 elevated and just slightly significant or non-significant in the fully adjusted model including
47
48 hospitalization due to alcohol and substance misuse and suicide attempt. The two criminal groups
49
50 were more likely to commit suicide by poisoning indicating prior experiences of substance misuse.
51
52 Hanging was most prevalent in the non-criminal group which is in line with the general population
53
54 in Sweden [31]. We suggest that authorities and the health care should observe the increased risk
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3 for suicide in both violent and non-violent criminals, especially those with earlier suicide attempt
4
5 and comorbid alcohol and substance misuse.
6

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8
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10

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12

13
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21
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23

24
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26
27 version of the manuscript. AS contributed to the planning and data analyses. JJ and AR
28
29 contributed to the planning of the study and preparing of the manuscript. All authors contributed
30
31 to the final draft of the manuscript.
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34 **Ethics approval:** Karolinska Institute Research Ethics Committee (Dnr 2007/174-31, Dnr
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36 2008/1086-31/5).
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Table 1. Risk factors and hospitalization in relation to non-violent and violent criminality

	No crime	Non-violent criminality	Violent criminality	Chisq, prob.**)
Fathers' social class				
III	47.67	50.38	58.07	
I-II	48.43	43.24	32.48	204.72, p<0.0001
Missing *)	3.90	6.37	9.45	
Medication for nervous problems in the family				
Yes (parents or other family members)	30.11	34.53	40.35	
No	67.02	61.61	54.11	201.34, p<0.0001
Missing	2.88	3.86	5.54	
Conduct problems at school				
Yes (at least once)	17.69	33.44	52.22	
No	81.39	65.05	45.45	2470.41, p<0.0001
Missing	0.92	1.51	2.33	
Own medication for psychiatric problems				
Yes	9.94	18.58	45.6	
No	89.02	85.22	77.23	293.35, p<0.0001
Missing	1.04	1.68	2.73	

Emotional control				
Very bad, bad	26.8	34.84	49.89	
Very good, good, medium	72.6	64.12	48.22	769.81, p<0.0001
Missing	0.70	1.04	1.89	
IQ				
Below average	16.03	23.24	35.69	
Above average, average	83.84	76.56	64.04	764.81, p<0.0001
Missing	0.13	0.20	0.26	
Psychiatric diagnosis (at conscription)				
Yes (at least one diagnosis)	9.73	15.87	29.85	
No	88.58	82.06	68.53	1008.59, p<0.0001
Missing	1.69	2.07	1.63	
Contact with police and juvenile authorities				
Yes (several or some times)	20.77	39.38	64.09	
No	77.86	58.62	33.14	3305.72, p<0.0001
Missing	1.37	2.00	2.77	
Risky alcohol use				
Yes	8.29	19.79	39.60	
No	90.43	78.40	57.58	2681.86, p<0.0001
Missing	1.28	1.81	2.91	
Dug misuse				
Yes	1.81	6.49	10.94	

No	94.00	88.53	82.22	1022, 23, p<0.0001
Missing	4.19	4.97	6.84	
Sniffing				
At least once	9.84	18.43	29.58	
No	88.82	79.38	66.81	1234.54, p<0.0001
Missing	1.34	2.19	3.60	
Hospitalization				
Alcohol hospitalization				
Yes (at least once)	1.76	10.75	31.96	
No	98.24	89.25	68.04	4464.28, p<.00001
Drug use hospitalization				
Yes (at least once)	0.15	2.48	11.65	
No	99.85	97.52	88.35	2269.25, p<.00001
Hospitalization for suicide attempts				
Yes (at least once)	0.94	4.10	13.54	
No	99.06	95.90	86.46	1647.76, p<0.0001

*) No answers were given to this item

**) p-value calculated for non-missing observations

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Suicide methods related to violent and non-violent criminality. Cox proportional regression analyses.		
Methods of suicide	Crime	HR , 95% CI
Poisoning (n=278): E950-E952, E980-E982, X60-X69, Y10-Y19	No crime	1.0
	Non-violent crime	2.94, 2.26-3.81
	Violent crime	6.92, 4.91-9.76
Hanging/suffocation (n=149): E953, E983, X70, Y20	No crime	1.0
	Non-violent crime	1.28, 0.90-1.83
	Violent crime	2.54, 1.47-4.40
Firearm (n=69): E955,E985, X722-X74, Y422-Y424	No crime	1.0
	Non-violent crime	1.39, 0.83-2.34
	Violent crime	3.08, 1.44-6.60
Drowning (n=41): E954, E984, X71,Y21	No crime	1.0
	Non-violent crime	1.62, 0.82-3.20
	Violent crime	5.17, 2.19-12.24
Jump from heights (n=27): E957, E987, X80, Y30	No crime	1.0
	Non-violent crime	3.23,1.43-7.26
	Violent crime	4.41, 1.21-16.00
Moving train (n=22): E9580, E9880, X81, Y31	No crime	1.0
	Non-violent crime	2.07, 0.84- 5.10
	Violent crime	4.40, 1.21- 15.98
Cutting (n=16): E956, E986,X79,Y28	No crime	1.0
	Non-violent crime	4.61, 1.58-13.50
	Violent crime	2.95, 0.35-25.23
Others (n=13): E958-959,E988-989, X75-X77, X79, X82-X84, Y425-Y27, Y29, Y32-Y34	No crime	1.0
	Non-violent crime	2.32, 0.67-8.01
	Violent crime	8.99, 2.15-37.63

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Table 3. Criminality in relation to suicide adjusted for early risk factors measured at conscription ¹⁾ and in addition adjusted for alcohol and drug inpatient and suicide attempt ²⁾ .					
Suicide					
N=615					
Criminality	No. of exposed	No. of cases	HR Crude	HR Adjusted ¹⁾	HR Adjusted ²⁾
Never	32376	275	1.0	1.0	1.0
Non-violent	14183	252	2.08, 1.72-2.52	1.65, 1.35- 2.01	1.35, 1.10- 1.67
Violent	2275	88	4.69, 3.56-6.19	2.68, 1.98-3.64	1.30, 0.92-1.82

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¹⁾ adjusted for fathers' social class, medication for nervous problems in the family, conduct problems at school, own medication for psychiatric disorder, contact with police and juvenile authorities, emotional control, intellectual capacity, psychiatric diagnosis at conscription, sniffing of solvents, risky alcohol misuse and substance misuse.

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²⁾ In addition adjusted for alcohol and drug inpatient and suicide attempt.

Table 4. Number of offences adjusted for early risk factors at conscription ¹⁾ and in addition for alcohol and drug inpatient and suicide attempt ²⁾.

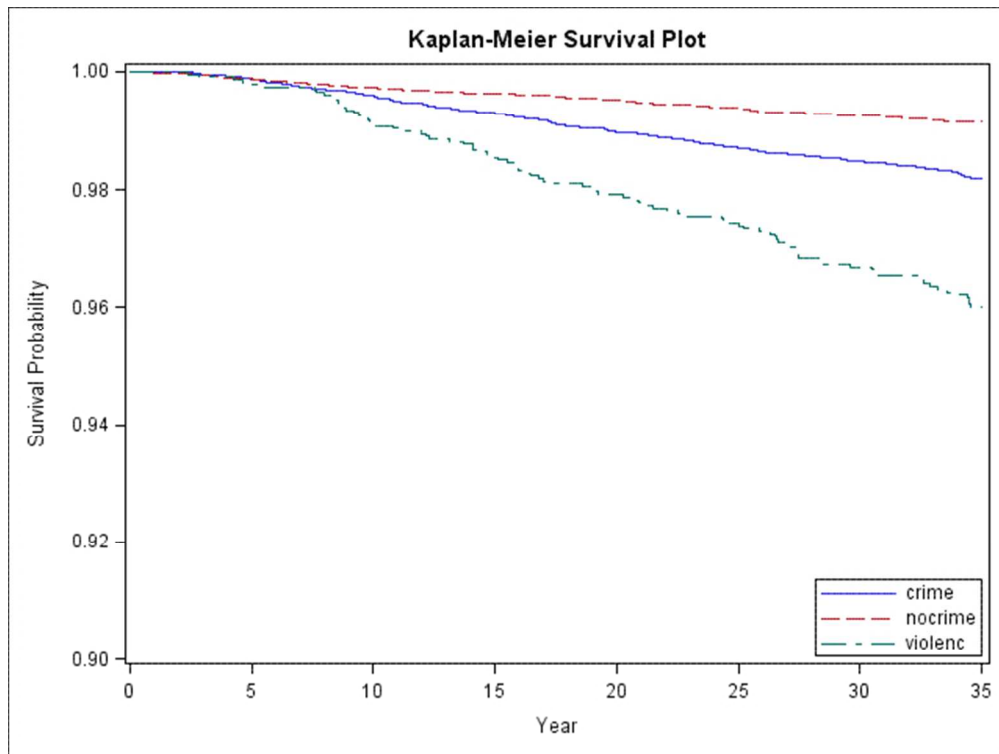
Suicide			
N=615			
Criminality	HR Crude	HR Adjusted ¹⁾	HR Adjusted ²⁾
Non-violent offence			
0 offence (n=32376, 66.30%)	1.0	1.0	1.0
1 offence (n=7322, 14.99%)	1.46, 1.15-1.85	1.25, 0.96-1.63	1.18, 0.91-1.55
2+ offences (n=9136, 18.71%)	3.27, 2.75-3.88	2.24, 1.81-2.77	1.49, 1.17-1.89
Violent offence	HR Crude	HR Adjusted ¹⁾	HR Adjusted ²⁾
0 offence (n=46559, 95.34%)	1.0	1.0	1.0
1 offence (n=1556, 3.19%)	2.65, 1.96-3.58	1.83, 1.29-2.59	1.17, 0.82-1.67
2+ offence (n=719, 1.47%)	5.40, 3.94-7.39	2.42, 1.61-2.59	0.84, 0.54-1.31

¹⁾ adjusted for fathers' social class, medication for nervous problems in the family, conduct problems at school, own medication for psychiatric disorder, contact with police and juvenile

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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	5
		(b) For matched studies, give matching criteria and number of exposed and unexposed	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6-8
Bias	9	Describe any efforts to address potential sources of bias	5,14
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	8
		(b) Describe any methods used to examine subgroups and interactions	8-9
		(c) Explain how missing data were addressed	14-15,22
		(d) If applicable, explain how loss to follow-up was addressed	8-9
		(e) Describe any sensitivity analyses	9
Results			14-15

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed (b) Give reasons for non-participation at each stage (c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (b) Indicate number of participants with missing data for each variable of interest (c) Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	Report numbers of outcome events or summary measures over time	8-9
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	9-11, 22-26
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	11
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	11-14
Generalisability	21	Discuss the generalisability (external validity) of the study results	
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	11

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

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

Criminality and Suicide—A longitudinal Swedish Cohort Study

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Keywords: criminality, risk factors, substance use, violence, suicide

Word count: 3698

ABSTRACT

Objectives: This study aimed to investigate whether both violent and non-violent offending was related to elevated risk of suicide in a male cohort of 49,398 18-20 years young men during a 35-years period. We also investigated if the risk was higher among those with repeated offences and how experiences of substance abuse and suicide attempt modified the relationship.

Design: A cohort study with a longitudinal design.

Participants: Possible confounders were obtained from a nationally representative birth cohort of 49,398 18-20 years young men who were mandatory conscripted for military service in 1969/70

The cohort has been linked to mortality and hospitalization and crime records from 1970 and

onwards. Estimates of suicide risk were calculated as hazard ratio (HR) with 95% confidence intervals (CI) using Cox proportional regression analyses with adjustment for potential confounding by family, psychological and behavioural factors including alcohol and substance use and psychiatric disorders.

Results: In the whole cohort, 29.04% had at least one non-violent and 4.7% violent conviction.

Suicide by poisoning was most prevalent in the criminal groups, while hanging in the non-criminals. In the crude model, the violent offenders had nearly five times higher risk (HR=4.80, 3.73-6.19) to die from suicide and non-violent criminals about two (HR=2.14, 1.79-2.56). In the fully adjusted model the hazard ratios were still significant for suicide.

Conclusions: Having experiences of violent or non-violent criminality were associated with increased risk of suicide. Co-morbidity with alcohol and substance use and psychiatric disorders modified the risk, but were still significant for non-violent criminals. It is crucial to identify offenders and especially repeated offenders who also suffer from alcohol or substance misuse and psychiatric illness in clinical settings in order to prevent suicide.

ARTICLE SUMMARY

Article focus

The aim of this cohort study was to analyse the association between violent and non-violent criminality and suicide in a large population based cohort of 49,398 18-20 years Swedish male conscripts followed-up for 35 years. Early confounders were collected through two questionnaires and interviews regarding psychosocial conditions including alcohol and substance use.

Criminality, suicide attempt and suicide data were collected through official registers.

Key messages

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- In Cox proportional regression analyses, the violent offenders had nearly five times higher hazard ratio to die from suicide and non-violent criminals about two. After controlling for early covariates, the hazard ratios still remained significant for suicide.
- Suicide attempt, severe alcohol and substance use measured at follow-up modified the risk of criminality on suicide.
- Poisoning as a suicide method was most prevalent in the criminal groups, while hanging in the non-criminals.

Strengths and limitations of this study

- The study is based on a large national cohort with a longitudinal design and with several adolescent confounders. Only a small part 2-3 % of the participants was excluded from the study mainly because of physical or psychiatric disorder/disability.
- This study adds knowledge about the association between violent and non-violent criminality and the risk of suicide.
- The limitations were that non-anonymous questionnaires were used, which have contributed to a lower response rate of especially problematic issues such as alcohol and substance use, but the response rate was nevertheless high.

INTRODUCTION

Almost one million people worldwide die from suicide every year. Suicide was accounted for 1.8% of the total disease burden in 1998 and has been estimated to be 2.4% by 2020.[1] Further, suicide is one of the three leading causes of mortality in the age category 15-44 years and the second among those aged 15-19.[2]

Earlier studies on the relationship between criminality and suicide have been mostly conducted on populations in prison or newly released from prison.[3-6] Studies have found an elevated risk of 5 to 9 and in some studies much higher depending on the age group for suicide among prison inmates compared to the general population and more than a third of the suicide cases had a history of criminality among men.[5-6]

Studies of suicide among offenders who are not in prisons are rather few, but an elevated risk in this population has also been reported.[7-8] Webb et al. examined various kinds of offences in a national population based study and found violent offences as the most important predictor for suicide with an odds ratio of nearly five and after adjustment for psychiatric admission, the odds decreased more than the double.[5]

In a Swedish national cohort study of 992 881 young adults both female and male repeated offenders had a suicide risk of about six times higher than non-offenders [9]. In the sub analyses controlled for psychiatric in-patient care and for substance abuse until the end of the follow-up, women had a risk of 3.7 and men had a risk of 3.0.[9]

A suicide attempt has been considered as the strongest clinical predictor of the subsequent suicide. The suicide risk after an attempt was up to 40 times the expected rate.[10] and lifetime prevalence suicide rates of suicide attempters with severe coexistent psychiatric disorder were even higher. [11]

In a Swedish national register based study, it was found that patients who had attempted suicide by hanging evinced highest risk to commit suicide in one year after the attempt.[12]

Studies on risk factors for suicide have stressed the importance of substance misuse for elevated mortality rates.[13-14] In most studies suicide is far higher in substance users than in the general population. For instance, Darke et al.[15] found about one third of the substance misusers had experiences of suicide attempts. Suicide among opioid misusers has been estimated to 14 times higher than the general population.[10,16] Further, one fifth or more of the suicide cases have substances presented in the blood.[15]

A previous study on the Swedish conscripts with a 13-years follow-up revealed that social and behavioural factors and neurotic and personality disorder measured at conscription were most

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7 significantly associated with high rate of suicide.[17] Likewise, in a recent longitudinal study of
8 the association between offenders and victims of violence and cause specific mortality found that
9 suicide carried a hazard ratio of about two after adjustment for various psychosocial confounders.
10 [13]

11
12 In this representative, nationwide, general population study we followed 49,398 Swedish
13 conscripts during 35 years, in order to examine whether both violent and non-violent offending
14 were related to elevated risk of suicide. We also investigated if the risk is higher among those with
15 repeated offences and how substance abuse and suicide attempt history modified the relationship.
16 Moreover, we studied the choice of suicide methods for the violent and non-violent criminal
17 groups.
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22 This study aimed to address four main research questions:

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24 (1) Do conscripts with violent or non-violent criminality differ in respect to hazard ratio of
25 suicide?
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27 (2) Does suicide risk increase with repeated offences?
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29 (3) Does history of previous suicide attempt and/or serious substance and alcohol misuse modify
30 the relationship between violent and non-violent criminality on suicide?
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32 (4) Do methods of suicide risks differ between the criminal groups?
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34 MATERIAL AND METHODS

35 Participants

36 This nationwide study is based on 49,398 18-20 years young Swedish men conscripted for
37 military service from 1 July 1969 to 30 June 1970 to 2004. About 2-3% was exempted from the
38 military service mainly because of a physical or psychiatric disorder/disability. In order to get a
39 homogenous age group we included 48,411 conscripts born 1949 to 1950. Six per cent of the
40 conscripts were born in 1949, 18 % in 1950 and 75 % in 1951. The mean age at the end of the
41 follow-up was about 53 years of age for the survivors.
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48 Measures

49 Measurement of potential confounders

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7 At conscription, each conscript was asked to answer two non-anonymous voluntary
8 questionnaires. The first included questions about family and psychosocial background and
9 health. The second about substance use including alcohol and drug use and sniffing of solvents.
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11 Studies have shown that the questionnaires have been found to have sufficient validity for
12 epidemiological studies[17-18].

13 Besides the measures of substance use, the confounders were selected from the conscription data,
14 based on the scientific studies and earlier studies of this cohort.[9,13,18-21] We included
15 11 confounders which have proved to be significant in the bivariate Cox proportional regression
16 analysis.

17 The confounders were: Fathers' social class (social class III vs. I-II). Medication for nervous
18 problems among parents or other members in the family (yes, at least one parent or family
19 member vs. no). Conduct problems at school (at least once vs. no). Any prior contact with police
20 and juvenile authorities (yes at least once vs. no). Having taken medication for psychiatric
21 disorder (at least once vs. no).

22 The psychological variables were: Emotional control and intellectual ability were assessed by
23 trained military psychologist who performed a structured interview with all conscripts. The
24 psychologists used both questionnaire and interview data and the measures were assessed on a 5-
25 point Likert scale. The ratings were regularly checked for interrater reliability, which was
26 satisfactory.[22] If the psychologist discovered or the conscript reported any psychiatric disorder,
27 the subject was referred to a psychiatrist and an eventual diagnosis was coded according to ICD-
28 8.[17, 22] Details of this procedure and the validity of the assessments have been described
29 earlier.[17, 23-24]

30 Intellectual ability (IQ) was based on four main intellectual and cognitive tests, measuring verbal,
31 logical-inductive, spatial, and technical and mechanical ability. The results of the tests were
32 aggregated in a 5-point summary score for overall intelligence, as described in detail by
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7 Ståhlberg[25] and David et al.[26] These scale of intelligence capacity was scored 1=very bad;
8 2=bad; 3=moderate; 4=good; 5=very good and expressed as intelligence (1–3 vs. 4–5). Details of
9 this procedure and the validity of the assessments have been described by Otto.[22]
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11 Problematic alcohol use was dichotomized (yes vs. no, with yes defined as one or more of
12 consumption of ≥ 210 g pure alcohol per week, having ever taken an ‘eye-opener’, being
13 intoxicated often, having been taking into custody for public drunkenness on at least one
14 occasion, and non-prescription drug (ever vs. never). Drug misuse was coded (yes vs. no), with
15 yes defined as used illicit drugs 10 times or more or any intravenous drug use.
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22 **Measures of alcohol and drug misuse and suicide attempt**

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24 Data from the National Swedish inpatient register were used to identify inpatient care with alcohol
25 and drug misuse according to ICD-8 and ICD-9 from 1987 and ICD-10 from 1997 onwards.
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27 The register includes details concerning inpatient care stays and days at hospital and diagnoses,
28 and has covered all public hospitals in Stockholm and Uppsala County since 1972, 85% of all
29 Swedish public inpatient care stays since 1983, and about 98–99% since 1987. The ICD
30 classifications for hospitalization and mortality were: Drug misuse – ICD-8: 304 and 965.0; ICD-
31 9: 304, 965A, 968F, 969G and 969H; and ICD-10: F11-12, F14, F15, F16, F18, F19, O35.5,
32 P04.4, T40.0–T40.3, T40.5–T40.9, T43.6, Z71.5, and X42. Alcohol misuse – ICD-8: 291, 303,
33 571.00, 571.01 and 980; ICD-9: 291, 303, 305A, 357F, 425F, 535D, 571A–571D and 980; and
34 ICD-10: E24.4, F10, G31.2, G62.1, G72.1, I42.6, K29.2, K70, K86.0, O35.4, P04.3, Q86.0, T51,
35 X45, Y91, Z50.2 and Z71.4. Suicide attempt: ICD-8 and ICD- 9: Determined suicide attempt:
36 E950-E959 and undetermined E980-E989; ICD-10: Determined X60-X84 and undetermined
37 suicide attempt: Y10-Y34.
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48 **Suicide**

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50 Cause of Death Register provides mortality data and covers more than 99% of all deaths
51 occurring in Sweden and is based on information from death certificates. Suicide was classified
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7 according to ICD-8 and ICD-9: E950-E959 and ICD-10: X60-X84 or as death with undetermined
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9 intent ICD-8 and ICD-9: E980-E989 and ICD-10: Y10-Y34. The same ICD-codes as for the
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11 hospital register.

12 **Measurement of crime**

14 Data from the National Crime Register were used to identify date, type, and number of criminal
15
16 offenses. The Crime Register contains information on all convictions in Sweden from 1966 and
17
18 onwards. Criminality was divided in three categories: no crime, violent crime and non-violent
19
20 crime. Violence was defined as: homicide, manslaughter and assault and non-violent crime all the
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22 other convictions. We also categorized the cohort according to number of crimes meaning for
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24 violent and non-violent offenders: (0, 1, and 2 or more crimes).

26 The data was linked at Statistics Sweden (Statistiska Centralbyrån) via the unique personal
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28 number for each individual, which thereafter was replaced with an individual serial number
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30 making the data anonymous to the research group, after approval of Karolinska Institute.

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31 **Statistical analyses**

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33 Cox proportional bivariate and multivariate regression analysis was used to calculate hazard ratios
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35 (HRs) with 95% confidence intervals (95% CI) for violent and non-violent criminality and
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37 suicide. We adjusted for early confounders measured at conscription in relation to time to
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39 suicide. The survival time was calculated from September 1969 until time of death for those who
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41 died during 1969 (2 subjects) and from 1 January 1970 until death or until 31 December 2004 for
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43 all other subjects in the cohort.

44 We had no exact information whether a person had emigrated from Sweden or not during the
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46 follow-up period, therefore we could not censor for emigration in the calculation of person time.

48 In order to investigate the association between the number of criminal offences and mortality, we
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50 categorized subjects according to committed numbers of offences (0, 1, 2 and more) in relation to
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52 the time to suicide by using Cox proportional regression analysis. We adjusted for potential risk
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factors as described above. These were measured at the time of conscription and only measured once why the time order was difficult to prove. Some of these variables like alcohol- or substance use could act as confounders or mediators on both criminality and suicide.

A test of the proportional hazard assumption was performed for each confounder in bivariate and multivariate analyses by using a time-dependent explanatory variable. If the p-value was significant ($p < .05$) the proportional hazard assumption was violated and the variable was not included in the analyses.

We used Kaplan-Meier survival curves to plot survival probability of suicide in non-criminals, violence and other criminality during the 35 years follow-up.

Chi-square (X^2) test was used when calculating early confounders and hospitalization in relation to criminality.

RESULTS

Of the total cohort, 2,671 (5.5%) died during the follow-up period. Of these 615 (23.6%) died due to suicide (474 determined and 141 undetermined). Suicide was prevalent in the criminal groups: no criminality (4.11%), non-violent (7.25%) and violent criminality (13.67%).

The suicide cases were rather equally distributed throughout the 35 years follow-up period.

More than one third (34%) of the suicide cases were 30 years or younger, 30% were in the age category 31-40 years and the remaining subjects (36%) were 41 years or older. The mean age was 36 years.

Table 1 shows the distribution of 11 confounders measured at conscription divided into the three groups of criminals. All risk factors differed significantly ($p < 0.0001$) between the groups, but mostly contact with the police or juvenile authorities, and having had conducted problems at school.

Regarding hospitalization of alcohol or drug misuse which had occurred during the follow-up period, alcohol misuse differed most significantly between the groups.

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Methods of suicide

Poisoning was the most prevalent method of suicide (n=278) followed by hanging and suffocation (n=149) (Table 2). The violent offenders had nearly seven times higher hazard to die from poisoning (HR=6.92, 95%CI 4.91-9.76), while the non-criminal group had twice lower risk (HR=2.94, 95%CI 2.26-3.81). The violent group had three times higher hazard ratio to die due to shooting by firearm, while the non-violent group had no significant risk.

Crude and multivariate analyses

Violent related criminality was mostly associated with suicide (HR=4.69, 95%CI 3.56-6.19) followed by non-violent criminality (HR=2.08, 95%CI 1.72-2.52) in bivariate analyses, while after adjustment for multiple confounders, the hazard ratios decreased to nearly three and two fold respectively (Table 3). In the fully adjusted model we also included alcohol and drug inpatient care stays and suicide attempt and found elevated hazard ratios, however, only significant in non-violent offenders.

Repeated violent and non-violent offenders in relation to suicide

Both repeated non-violent and violent offences were associated with elevated hazard ratios of suicide in crude analyses (HR=3.27 and HR=5.40). When adjusted for early confounders the repeaters of both violent and non-violent offenders decreased to HRs=2.42 and 2.34, respectively (Table 4).

We conducted Kaplan-Meier survival distribution curves for the three criminal groups in relation to suicide from 1970 up to 2004. We found that violent criminality was associated with lower survival (Fig 1).

DISCUSSION

This study aimed to analyse suicide in three groups concerning criminal offences: non-criminal, violent and non-violent criminal offenders.

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7 We found that nearly one third of the death cases were due to suicide in those who had ever
8 committed a violent offence and one fourth in the non-violent group, which is in line with earlier
9 studies reporting high proportionate mortality (the percentage of the dead who died by suicide)
10 among homicide offenders and among personality-disordered offenders subject to forensic
11 psychiatric assessment.[27-29]

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16 The main finding was that violent offenders had nearly five times higher crude risk and non-
17 violent offenders more than two-fold higher risk for suicide compared to no criminals. Even after
18 controlling for multiple confounders measured at conscription the hazard ratios remained
19 significant. Alcohol and substance misuse and attempted suicide in the fully adjusted model were
20 confounding on suicide remaining barely significant or non-significant risk for suicide. This imply
21 a strong association between these clinical predictors and suicide risk.[11,30] However, we do not
22 have knowledge about the time order between criminality and the clinical factors measured during
23 the follow-up period, why we have to take the results with cautions.

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28 We found that poisoning as method of completed suicide was most prevalent in violent and non-
29 violent criminals, while hanging was the most prevalent method among non-criminals. That was

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32 also the case for men in the whole of Sweden.[31] In a Danish national register study of 9708

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suicide cases and 188,134 age and gender matched living controls, hanging was the leading
suicide method among men, while poisoning among women.[32-33] One possible explanation to

the high prevalence of poisoning in criminals in our study could be that alcohol and substance use
was more prevalent in the criminal groups including fatal and non-fatal poisonings compared to
non-criminals.

There is some evidence in the literature that violent criminals have higher rates of suicide, but
these numbers are often derived from prison populations with often difficult circumstances such as
overcrowded cells and spaces which may contribute to psychiatric illness.[34] Very few earlier

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7 studies on the association between violent and non-violent criminality and suicide have been
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9 conducted in a cohort representing the general population and with a long follow-up period.
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11 However, national data from England and Wales found after age standardization, 9- to 13-fold
12 increased risk for suicide in both prisoners and non-custody offenders.[34]
13

14 The yearly incidence rates of suicide have not shown a clear decrease in the younger age
15 categories in Sweden, why it is important to identify delinquency at young ages and other risk
16 factors in order to find preventive strategies for this group.[5] Generally, suicide rates are higher
17 among the older age groups, often due to loneliness, anxiety disorder and depression.[35-36] In
18 this study, the suicide cases were rather equally distributed throughout the 35 years follow-up
19 period which probably means that all age categories seem to be vulnerable for suicide.
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21 It has been argued that suicide attempts by poisoning nowadays have mostly non-fatal outcome
22 because of lower dosages after the introduction of blister packaging and often being rescued by
23 accessible emergency care [37-38], indicating the importance of analysing both licit and illicit
24 drugs involving in suicide. As mentioned above the criminal groups are more likely to use illicit
25 drugs and additionally alcohol and prescribed drugs.[11, 35]
26

27 Suicide attempts had been experienced by 1192 men (2.4%), which could be considered as rather
28 low frequency when comparing with the completed suicides (n=615). An American national
29 study (National Survey on Drug Use and Health), based on interviews and web-questionnaires
30 from 92,264 respondents in year 2008 and 2009, found one suicide case for every 25 attempted
31 suicides.[39] We had data on only suicide attempts needing inpatient care, namely serious suicide
32 attempts, which could explain the ratio. We did not have data on attempted suicides that not turn
33 up as hospital records. Some suicide attempters do not search help at any care givers.[40-41]. In
34 our study, one out of five suicide victims had attempted suicide, confirming a strong association
35 between attempted and completed suicide. This was especially evident for violent offenders where
36 one in three had experienced attempted suicide. Suicide attempt has been considered as one of the
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7 strongest predictors of suicide and the risk seem to be elevated up to older ages and during long
8 time periods.[42] Alcohol misuse has also in other studies been pointed out as a severe risk factor
9 for suicide and in some studies the second most common diagnostic group.[35,43]. Wilcox et
10 al.[16] found alcohol misusers having a 10-fold increase risk for suicide in a mixed-age cohort.
11 Likewise, in a longitudinal cohort study by Flensburg-Madsen et al.,[44] individuals with alcohol
12 use disorders had eight times higher hazard ratios of suicide compared to individuals with no
13 alcohol use. The hazard ratio fell to three after adjustment of psychiatric disorders. These findings
14 indicate the importance of early detection and prevention strategies and treatment for substance
15 users and especially those with suicidal tendencies in all ages.[36] In the present study, about half
16 of the violent offenders had reported either risky alcohol or substance use at the time of
17 conscription and nearly one third had been treated at hospital for an alcohol related diagnosis. The
18 relationship between alcohol use and violence seems to be complex.[45] The fact that the suicide
19 rate is somewhat higher in the violent criminals than non-violent criminals, one could assume that
20 alcohol misuse play an important role for both violence and suicide [43].

21 We found that one third of the violent offenders were already diagnosed at conscription with a
22 psychiatric diagnosis. Psychiatric disorders are strongly related to suicide risk, whereas the
23 association between mental illness and violent crime is not as evident. King and Barraclough[45]
24 found 27 times higher risk of unnatural death (suicide, accident and undetermined) among
25 individuals who had recently been in contact with psychiatric clinics compare to those who had
26 not. Persons with severe psychiatric disorders like affective disorder and schizophrenia have
27 highly elevated lifetime suicide risk.[46-47]

28 **Advantages and limitations**

29 An advantage of this study is the large national cohort with a longitudinal design and with several
30 adolescent covariates. Only a small part 2-3 % of the conscripts was excluded from the study
31 mainly because of physical or psychiatric disorders. The two questionnaires used at conscription
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7 were non-anonymous, which could have contributed to a lower response rate of especially
8 problematic issues such as alcohol and substance use. However, other studies on conscription
9 cohort have compared register and self-reported information of alcohol and substance use and
10 found good agreement between the different sources of data [23]. A small number of the
11 conscripts missed one or some of the items in the questionnaires. That was especially evident for
12 those subjects who had committed violent offences whereas the response rate for the confounders
13 included in the study varied from 0.26 to 9.45%. The corresponding measures for other criminality
14 and non-criminals were: 0.20 to 6.37% and 0.13 to 4.19%. The violent offenders had probably
15 more severe risk factors than the non-violent and non-criminal groups which could have resulting
16 in underestimating of the hazard ratios of suicide. One could assume that these subjects also had
17 higher rates of substance use and other maladjusted behaviour measured at conscription which in
18 turn could have affected the outcome.[48] However, we have no reason to believe that the risk for
19 the outcome, suicide, has been considerable affected due the internal missing data.

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31 Another limitation of this study is that we do not have information about criminality not turning
32 up in the register. Some subjects could have committed many violent and non-violent crimes,
33 especially in combination with substance misuse, and never been convicted of a crime.

34 35 36 37 **Conclusions**

38
39 We found that individuals registered for either violent or other criminality are at increased risk for
40 committing suicide in crude analysis and that is especially evident for those who were criminal
41 repeaters. However, after adjusting for confounders measured at conscription the risk was still
42 elevated and just slightly significant or non-significant in the fully adjusted model including
43 hospitalization due to alcohol and substance misuse and suicide attempt. The two criminal groups
44 were more likely to commit suicide by poisoning indicating prior experiences of substance misuse.
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50 Hanging was most prevalent in the non-criminal group which is in line with the general population
51 in Sweden [31]. We suggest that authorities and the health care should observe the increased risk
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7 for suicide in both violent and non-violent criminals, especially those with earlier suicide attempt
8 and comorbid alcohol and substance misuse.

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25 version of the manuscript. AS contributed to the planning and data analyses. JJ and AR
26 contributed to the planning of the study and preparing of the manuscript. All authors contributed
27 to the final draft of the manuscript.

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33 **Ethics approval:** Karolinska Institute Research Ethics Committee (Dnr 2007/174-31, Dnr
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Table 1. Risk factors and hospitalization in relation to non-violent and violent criminality				
	No crime	Non-violent criminality	Violent criminality	Chisq, prob.**)
Fathers' social class				
III	47.67	50.38	58.07	
1-II	48.43	43.24	32.48	204.72, p<0.0001
Missing *)	3.90	6.37	9.45	
Medication for nervous problems in the family				
Yes (parents or other family members)	30.11	34.53	40.35	
No	67.02	61.61	54.11	201.34, p<0.0001
Missing	2.88	3.86	5.54	
Conduct problems at school				
Yes (at least once)	17.69	33.44	52.22	
No	81.39	65.05	45.45	2470.41, p<0.0001
Missing	0.92	1.51	2.33	
Own medication for psychiatric problems				
Yes	9.94	1858	456	
No	89.02	85.22	77.23	293,35, p<0.0001
Missing	1.04	1.68	2.73	

Emotional control				
Very bad, bad	26.8	34.84	49.89	
Very good, good, medium	72.6	64.12	48.22	769.81, p<0.0001
Missing	0.70	1.04	1.89	
IQ				
Below average	16.03	23.24	35.69	
Above average, average	83.84	76.56	64.04	764.81, p<0.0001
Missing	0.13	0.20	0.26	
Psychiatric diagnosis (at conscription)				
Yes (at least one diagnosis)	9.73	15.87	29.85	
No	88.58	82.06	68.53	1008.59, p<0.0001
Missing	1.69	2.07	1.63	
Contact with police and juvenile authorities				
Yes (several or some times)	20.77	39.38	64.09	
No	77.86	58.62	33.14	3305.72, p<0.0001
Missing	1.37	2.00	2.77	
Risky alcohol use				
Yes	8.29	19.79	39.60	
No	90.43	78.40	57.58	2681.86, p<0.0001
Missing	1.28	1.81	2.91	
Dug misuse				
Yes	1.81	6.49	10.94	

No	94.00	88.53	82.22	1022, 23, p<0.0001
Missing	4.19	4.97	6.84	
Sniffing				
At least once	9.84	18.43	29.58	
No	88.82	79.38	66.81	1234.54, p<0.0001
Missing	1.34	2.19	3.60	
Hospitalization				
Alcohol hospitalization				
Yes (at least once)	1.76	10.75	31.96	
No	98.24	89.25	68.04	4464.28, p<.00001
Drug use hospitalization				
Yes (at least once)	0.15	2.48	11.65	
No	99.85	97.52	88.35	2269.25, p<.00001
Hospitalization for suicide attempts				
Yes (at least once)	0.94	4.10	13.54	
No	99.06	95.90	86.46	1647.76, p<0.0001

*) No answers were given to this item

**) p-value calculated for non-missing observations

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Suicide methods related to violent and non-violent criminality. Cox proportional regression analyses.		
Methods of suicide	Crime	HR , 95% CI
Poisoning (n=278): E950-E952, E980-E982, X60-X69, Y10-Y19	No crime	1.0
	Non-violent crime	2.94, 2.26-3.81
	Violent crime	6.92, 4.91-9.76
Hanging/suffocation (n=149): E953, E983, X70, Y20	No crime	1.0
	Non-violent crime	1.28, 0.90-1.83
	Violent crime	2.54, 1.47-4.40
Firearm (n=69): E955,E985, X722-X74, Y422-Y424	No crime	1.0
	Non-violent crime	1.39, 0.83-2.34
	Violent crime	3.08, 1.44-6.60
Drowning (n=41): E954, E984, X71,Y21	No crime	1.0
	Non-violent crime	1.62, 0.82-3.20
	Violent crime	5.17, 2.19-12.24
Jump from heights (n=27): E957, E987, X80, Y30	No crime	1.0
	Non-violent crime	3.23,1.43-7.26
	Violent crime	4.41, 1.21-16.00
Moving train (n=22): E9580, E9880, X81, Y31	No crime	1.0
	Non-violent crime	2.07, 0.84- 5.10
	Violent crime	4.40, 1.21- 15.98
Cutting (n=16): E956, E986,X79,Y28	No crime	1.0
	Non-violent crime	4.61, 1.58-13.50
	Violent crime	2.95, 0.35-25.23
Others (n=13): E958-959,E988-989, X75-X77, X79, X82-X84, Y425-Y27, Y29, Y32-Y34	No crime	1.0
	Non-violent crime	2.32, 0.67-8.01
	Violent crime	8.99, 2.15-37.63

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Table 3. Criminality in relation to suicide adjusted for early risk factors measured at conscription ¹⁾ and in addition adjusted for alcohol and drug inpatient and suicide attempt ²⁾.

Suicide					
N=615					
Criminality	No. of exposed	No. of cases	HR Crude	HR Adjusted ¹⁾	HR Adjusted ²⁾
Never	32376	275	1.0	1.0	1.0
Non-violent	14183	252	2.08, 1.72-2.52	1.65, 1.35- 2.01	1.35, 1.10- 1.67
Violent	2275	88	4.69, 3.56-6.19	2.68, 1.98-3.64	1.30, 0.92-1.82

¹⁾ adjusted for fathers' social class, medication for nervous problems in the family, conduct problems at school, own medication for psychiatric disorder, contact with police and juvenile authorities, emotional control, intellectual capacity, psychiatric diagnosis at conscription, sniffing of solvents, risky alcohol misuse and substance misuse.

²⁾ In addition adjusted for alcohol and drug inpatient and suicide attempt.

Table 4. Number of offences adjusted for early risk factors at conscription ¹⁾ and in addition for alcohol and drug inpatient and suicide attempt ²⁾.

Suicide N=615			
Criminality	HR Crude	HR Adjusted ¹⁾	HR Adjusted ²⁾
Non-violent offence			
0 offence (n=32376, 66.30%)	1.0	1.0	1.0
1 offence (n=7322, 14.99%)	1.46, 1.15-1.85	1.25, 0.96-1.63	1.18, 0.91-1.55
2+ offences (n=9136, 18.71%)	3.27, 2.75-3.88	2.24, 1.81-2.77	1.49, 1.17-1.89
Violent offence	HR Crude	HR Adjusted ¹⁾	HR Adjusted ²⁾
0 offence (n=46559, 95.34%)	1.0	1.0	1.0
1 offence (n=1556, 3.19%)	2.65, 1.96-3.58	1.83, 1.29-2.59	1.17, 0.82-1.67
2+ offence (n=719, 1.47%)	5.40, 3.94-7.39	2.42, 1.61-2.59	0.84, 0.54-1.31

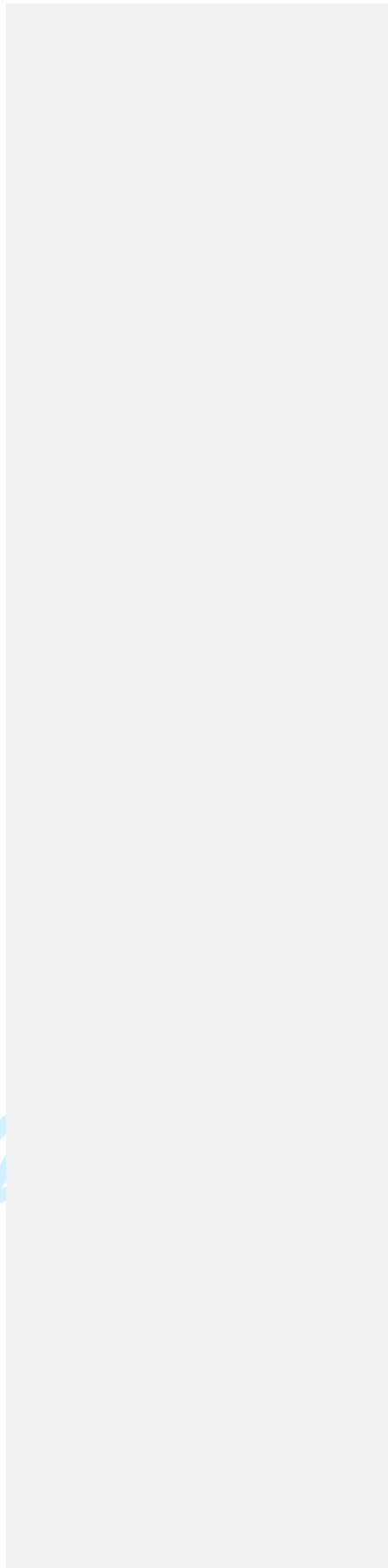
¹⁾ adjusted for fathers' social class, medication for nervous problems in the family, conduct problems at school, own medication for psychiatric disorder, contact with police and juvenile

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authorities, emotional control, intellectual capacity, psychiatric diagnosis at conscription, sniffing of solvents, risky alcohol misuse and substance misuse.

2) In addition adjusted for alcohol and drug inpatient and suicide attempt.

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Criminality and Suicide – A longitudinal Swedish Cohort Study

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Criminality and Suicide—A longitudinal Swedish Cohort Study

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ABSTRACT

Objectives: This study aimed to investigate whether both violent and non-violent offending was related to elevated risk of suicide. We also investigated if the risk was higher among those with repeated offences and how experiences of substance abuse and suicide attempt modified the relationship.

Design: A nationwide prospective cohort study.

Setting: A register study of 49,398 conscripted men in 1969/70 in Sweden followed up during a 35-years period in official registers.

Participants: A Birth cohort of 49,398 men who were mandatory conscripted for military service in 1969/70 at age of 18-20 years. Possible confounders were retrieved from psychological assessments at conscription and the cohort was linked to mortality and hospitalization and crime records from 1970 and onwards. Estimates of suicide risks were calculated as hazard ratio (HR) with 95% confidence intervals (CI) using Cox proportional regression analyses with adjustment for potential confounding by family, psychological and behavioural factors including substance use and psychiatric disorders.

Results: Of the total cohort 2,671 (5.5%) persons died during the follow-up period. Of these 615 (23.6%) died due to suicide. Non-violent criminality was evident for 29.0% and violent criminality for 4.7% of all the participants. In the crude model, the violent offenders had nearly five times higher risk (HR=4.80, 3.73-6.19) to die from suicide and non-violent criminals about two (HR=2.14, 1.79-2.56). In the fully adjusted model the hazard ratios were still significant for suicide.

Conclusions: Experiences of violent or non-violent criminality were associated with increased risk of suicide. Co-morbidity with alcohol and substance use and psychiatric disorders modified the risk, but the suicide risk remained significantly elevated for non-violent criminals. It is crucial to identify offenders and especially repeated offenders who also suffer from alcohol or substance misuse and psychiatric illness in clinical settings in order to prevent suicide.

ARTICLE SUMMARY

Article focus

The aim of this cohort study was to analyse the association between violent and non-violent criminality and suicide in a large population based cohort of 49.398 18-20 years Swedish male conscripts followed-up for 35 years. Early confounders were collected through two questionnaires and interviews regarding psychosocial conditions including alcohol and substance use.

Criminality, suicide attempt and suicide data were collected through official registers.

Key messages

- In Cox proportional regression analyses, the violent offenders had nearly five times higher hazard ratio to die from suicide and non-violent criminals about two. After controlling for early covariates, the hazard ratios still remained significant for suicide.
- Suicide attempt, severe alcohol and substance use measured at follow-up modified the risk of criminality on suicide.
- Poisoning as a suicide method was most prevalent in the criminal groups, while hanging in the non-criminals.

Strengths and limitations of this study

- The study is based on a large national cohort with a longitudinal design and with several adolescent confounders. Only a small part 2-3 % of the participants was excluded from the study mainly because of physical or psychiatric disorder/disability.
- This study adds knowledge about the association between violent and non-violent criminality and the risk of suicide.
- The limitations were that non-anonymous questionnaires were used, which may have contributed to a lower response rate of especially problematic issues such as alcohol and substance use, but the response rate was nevertheless high.

INTRODUCTION

Almost one million people worldwide die from suicide every year. Suicide was accounted for 1.8% of the total disease burden in 1998 and has been estimated to be 2.4% by 2020.[1] Further, suicide is one of the three leading causes of mortality in the age category 15-44 years and the second among those aged 15-19.[2]

Earlier studies on the relationship between criminality and suicide have been mostly conducted on populations in prison or newly released from prison.[3-6] Studies have found an elevated risk of 5 to 9 and in some studies much higher depending on the age group for suicide among prison inmates compared to the general population and more than a third of the male suicide cases had a history of criminality.[5-6]

Studies of suicide among offenders who are not in prisons are rather few, but an elevated risk in this population has also been reported.[7-8] Webb et al. examined suicide risk among people processed by Danish criminal justice system in a nested case-control study of 27,219 suicide cases and 524,899 matched living controls over 3 decades. More than one third of the male cases had a criminal history and when comparing with the general population custodial sentence, and psychiatric treatment and violent offences were important predictors for suicide.[5]

In a Swedish national cohort study of 992 881 young adults found that both female and male repeated offenders had a suicide risk of about six times higher than non-offenders. [9] Young female offenders had a risk of 3.7 and young male offenders had a risk of 3.0 after control for psychiatric in-patient care and for substance abuse until the end of the follow-up.[9]

A suicide attempt has been considered as the strongest predictor of the subsequent suicide. The suicide risk after an attempt was up to 40 times the expected rate[10] and lifetime prevalence suicide rates of suicide attempters with severe coexistent psychiatric disorder were even higher.

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3 In a Swedish national register based study, it was found that patients who had attempted suicide by
4 hanging evinced highest risk for suicide in one year after the attempt.[12]
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7 Studies on risk factors for suicide have stressed the importance of substance misuse for elevated
8 mortality rates.[13-14] In most studies suicide is far more prevalent in substance users than in the
9 general population. For instance, Darke et al.[15] found that about one third of the substance
10 misusers had experiences of suicide attempts. Suicide among opioid misusers has been estimated
11 to be 14 times higher than the general population.[10,16] Further, one fifth or more of the suicide
12 cases had substances presented in the blood in one study.[15]
13

14
15 A previous study on the Swedish conscripts with a 13-years follow-up revealed that social and
16 behavioural factors and neurotic and personality disorder measured at conscription were most
17 significantly associated with high rate of suicide.[17] Likewise, a longitudinal study of offenders
18 and victims of violence and cause specific mortality showed that the hazard ratio for suicide risk
19 was about two after adjustment for various psychosocial confounders.[13]
20

21
22 In this representative, nationwide, general population study we followed 49,398 Swedish
23 conscripts during 35 years, in order to examine whether violent and non-violent offending were
24 related to elevated risk of suicide. We also investigated if the risk was higher among those with
25 repeated offences and how substance abuse and suicide attempt history modified the relationship.
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27 Moreover, we studied the choice of suicide methods for the violent and non-violent criminal
28 groups.
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32 This study aimed to address four main research questions:
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35 (1) Do conscripts with violent or non-violent criminality offences differ in respect to risk of
36 suicide?
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38 (2) Does suicide risk increase with repeated offences?
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3 (3) Does history of previous suicide attempt and/or serious substance and alcohol misuse modify
4 the relationship between violent and non-violent criminality on suicide?
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7 (4) Do methods of suicide differ between the criminal groups?
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10 11 **MATERIAL AND METHODS**

12 13 **Participants**

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15 This nationwide study is based on 49,398 18-20 years young Swedish men conscripted for
16 military service from 1 July 1969 to 30 June 1970. About 2-3% was exempted from the military
17 service mainly because of a physical or psychiatric disorder/disability. In order to get a
18 homogenous age group we included 48,411 conscripts born 1949 to 1951. Six per cent of the
19 conscripts were born in 1949, 18 % in 1950 and 75 % in 1951. The mean age at the end of the
20 follow-up was about 53 years of age for the survivors.
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23 24 **Measures**

25 26 **Measurement of potential confounders**

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28 At conscription, each conscript was asked to answer two non-anonymous voluntary
29 questionnaires. The first included questions about family and psychosocial background and
30 health. The second about substance use including alcohol and drug use and sniffing of solvents.
31 Studies have shown that the questionnaires have been found to have sufficient validity for
32 epidemiological studies.[17-18]
33

34 Besides the measures of substance use, the confounders were selected from the conscription data,
35 based on the scientific studies and earlier studies of this cohort.[9,13,18-21]
36

37 The confounders were: Father's occupation: social class I+II vs. social class III.
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39 Social class I includes proprietors, private entrepreneurs and high salaried employees in private
40 entrepreneurs and high-income employees in private and public sectors, Social class II other
41 incomes and small entrepreneurs, and social class III mainly blue-collar workers.[22]
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3 Medication for nervous problems among parents or other members in the family (yes, at least one
4 parent or family member vs. no). Conduct problems at school (at least once vs. no). Any prior
5 contact with police and juvenile authorities (yes at least once vs. no). Having taken medication for
6 psychiatric disorder (at least once vs. no).
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11 The psychological variables were: Emotional control and intellectual capacity were assessed by
12 trained military psychologist who performed a structured interview with all conscripts. The
13 psychologists used both questionnaire and interview data and the measures were assessed on a 5-
14 point Likert scale. The ratings were regularly checked for interrater reliability, which was
15 satisfactory.[23] If the psychologist discovered or the conscript reported any psychiatric disorder,
16 the subject was referred to a psychiatrist and an eventual diagnosis was coded according to ICD-
17 8.[17, 23] Details of this procedure and the validity of the assessments have been described
18 earlier.[17, 23-25]
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21
22 Intellectual capacity (IQ) was based on four main intellectual and cognitive tests, measuring
23 verbal, logical-inductive, spatial, and technical and mechanical ability. The results of the tests
24 were aggregated in a 5-point summary score for overall intelligence, as described in detail by
25 Ståhlberg[26] and David et al.[27] These scale of intelligence capacity was scored 1=very bad;
26 2=bad; 3=moderate; 4=good; 5=very good and expressed as intelligence (1–3 vs. 4–5). Details of
27 this procedure and the validity of the assessments have been described by Otto.[23]
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31 Problematic alcohol use was dichotomized (yes vs. no, with yes defined as one or more of
32 consumption of ≥ 210 g pure alcohol per week, having ever taken an ‘eye-opener’, being
33 intoxicated often, having been taking into custody for public drunkenness on at least one
34 occasion, and non-prescription drug (ever vs. never). Drug misuse was coded (yes vs. no), with
35 yes defined as used illicit drugs 10 times or more or any intravenous drug use.
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43 **Measures of alcohol and drug misuse and suicide attempt**

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3 Data from the National Swedish inpatient register were used to identify inpatient care with an
4 alcohol or drug diagnosis of dependence or abuse according to ICD-8 and ICD-9 from 1987 and
5 ICD-10 from 1997 onwards.
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9 The register includes details concerning inpatient care stays and days at hospital and diagnoses,
10 and has covered all public hospitals in Stockholm and Uppsala County since 1972, 85% of all
11 Swedish public inpatient care stays since 1983, and about 98–99% since 1987. The ICD
12 classifications for hospitalization and mortality were: Drug misuse – ICD-8: 304 and 965.0; ICD-
13 9: 304, 965A, 968F, 969G and 969H; and ICD-10: F11-12, F14, F15, F16, F18, F19, O35.5,
14 P04.4, T40.0–T40.3, T40.5–T40.9, T43.6, Z71.5, and X42. Alcohol misuse – ICD-8: 291, 303,
15 571.00, 571.01 and 980; ICD-9: 291, 303, 305A, 357F, 425F, 535D, 571A–571D and 980; and
16 ICD-10: E24.4, F10, G31.2, G62.1, G72.1, I42.6, K29.2, K70, K86.0, O35.4, P04.3, Q86.0, T51,
17 X45, Y91, Z50.2 and Z71.4. Suicide attempt: ICD-8 and ICD- 9: Determined suicide attempt:
18 E950-E959 and undetermined E980-E989; ICD-10: Determined X60-X84 and undetermined
19 suicide attempt: Y10-Y34.
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34 **Suicide**

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36 Information about suicide was obtained from Cause of Death Register which provides mortality
37 data and covers more than 99% of all deaths occurring in Sweden and is based on information
38 from death certificates. Suicide was classified according to ICD-8 and ICD-9: E950-E959 and
39 ICD-10: X60-X84 or as death with undetermined intent ICD-8 and ICD-9: E980-E989 and ICD-
40 10: Y10-Y34. The same ICD-codes as for the hospital register.
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47 **Measurement of crime**

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49 Data from the National Crime Register were used to identify date, type, and number of criminal
50 offenses. The Crime Register contains information on all convictions in Sweden from 1966 and
51 onwards. Criminality was divided in three categories: no crime, violent crime and non-violent
52 crime. Violence was defined as: homicide, manslaughter and assault and non-violent crime all the
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3 other convictions. We also categorized the cohort according to number of crimes meaning for
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5 violent and non-violent offenders: (0, 1, and 2 or more crimes).
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7 Information about alcohol and drug inpatient-care, criminality and suicide was linked at
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9 Statistics Sweden (Statistiska Centralbyrån) via the unique personal number for each individual in
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11 the cohort. This personal number was then replaced with an individual serial number making the
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13 data anonymous to the research group, after approval of Regional ethical review board in
14
15 Stockholm.
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17 18 **Statistical analyses** 19

20 Cox proportional bivariate and multivariate regression analysis was used to calculate hazard ratios
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22 (HRs) with 95% confidence intervals (95% CI) for violent and non-violent criminality and
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24 suicide. We adjusted for confounders measured at conscription in relation to time to suicide. The
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26 surveillance time was calculated from September 1969 until death or until 31 December 2004 for
27
28 all subjects in the cohort.
29

30
31 We had no exact information whether a person had emigrated from Sweden or not during the
32
33 follow-up period, therefore we could not censor for emigration in the calculation of person time.
34

35
36 In order to investigate the association between the number of criminal offences and mortality, we
37
38 categorized subjects according to committed numbers of offences (0, 1, 2 and more) in relation to
39
40 the time to suicide by using Cox proportional regression analysis. These were measured at the
41
42 time of conscription and only measured once why the time order was difficult to prove. Some of
43
44 these variables like alcohol- or substance use could act as confounders or mediators on both
45
46 criminality and suicide.
47

48
49 A test of the proportional hazard assumption was performed for each confounder (X) in bivariate
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51 and multivariate analyses by using a time-dependent explanatory variable in the model (X*(log
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53 time – average value of the log time)). If the p-value was significant (p<.05) the proportional
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55 hazard assumption was not fulfilled and the variable was not included in the analyses.
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5 We used Kaplan-Meier survival curves to plot survival probability of suicide in non-criminals,
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7 violence and other criminality during the 35 years follow-up.
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10 Chi-square (X^2) test was used when calculating early confounders and hospitalization in relation
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12 to criminality.
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14 15 16 **RESULTS**

17
18 Of the total cohort, 2,671 subjects (5.5%) died during the follow-up period. Of these 615 (23.6%)
19
20 died due to suicide (474 determined and 141 undetermined). Suicide was more prevalent in the
21
22 criminal groups: no criminality (4.11%), non-violent (7.3%) and violent criminality (13.7%).
23

24
25 The suicide cases were rather equally distributed throughout the 35 years follow-up period.
26

27
28 More than one third (34%) of the suicide cases were 30 years or younger, 30% were in the age
29
30 category 31-40 years and the remaining subjects (36%) were 41 years or older. The mean age was 36
31
32 years.
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34
35 Table 1 shows the distribution of 11 confounders measured at conscription divided into the three
36
37 groups of criminals. All risk factors differed significantly ($p < 0.0001$) between the groups, but mostly
38
39 prior contact with the police or juvenile authorities, and having had conducted problems at school.
40

41
42 Regarding hospitalization of alcohol or drug misuse which had occurred during the follow-up period,
43
44 alcohol misuse differed most significantly between the groups.
45

46 **Methods of suicide**

47
48 Poisoning was the most prevalent method of suicide ($n=278$) followed by hanging and suffocation
49
50 ($n=149$) (Table 2). The violent offenders had nearly seven times higher hazard to die from poisoning
51
52 ($HR=6.92$, 95%CI 4.91-9.76), while the non-violent criminal group had almost three times higher
53
54 risk ($HR=2.94$, 95%CI 2.26-3.81). The violent group had three times higher hazard ratio to die due to
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56 shooting by firearm, while the non-violent group had no significant risk.
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Crude and multivariate analyses

Violent related criminality had the highest hazard ratio for suicide (HR=4.69, 95%CI 3.56-6.19) followed by non-violent criminality (HR=2.08, 95%CI 1.72-2.52) in bivariate analyses. After adjustment for multiple confounders, the hazard ratios decreased to nearly three (HR=2.68) and two fold (HR=1.65) respectively (Table 3). Four out of 11 of the confounders in the model e.g. low emotional control (HR=1.4), low intellectual capacity (1.36), own medication for psychiatric problems (HR=1.40) and medication for nervous problem in the family (HR=1.23) were significantly associated with suicide. In the fully adjusted model we also included alcohol and drug inpatient care stays and suicide attempt and found elevated hazard ratios, however, only significant in non-violent offenders (HR=1.35, 95%CI 1.10-1.67). All these three inpatient-care variables were associated with suicide: suicide attempt carried an hazard of 4.83, while alcohol and drug misuse had lower hazards (2.00 and 1.74, respectively).

Repeated violent and non-violent offenders in relation to suicide

Both repeated non-violent and violent offences were associated with elevated hazard ratios of suicide in crude analyses (HR=3.27 and HR=5.40). When adjusted for early confounders the repeaters of both violent and non-violent offenders decreased to HRs=2.42 and 2.24, respectively (Table 4).

We conducted Kaplan-Meier survival distribution curves for the three criminal groups in relation to suicide from 1970 up to 2004. We found that violent criminality was associated with lower survival (Fig 1).

DISCUSSION

One aim of this study was to analyse the association between male violent and non-violent offending and risk for suicide in a population-based cohort during a 35-years follow-up.

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3 A main finding was that nearly one third of the death cases were due to suicide in those who had
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5 ever committed a violent offence and one fourth in the non-violent group. This is in line with
6
7 earlier studies reporting high proportionate mortality among homicide offenders and among
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9 personality-disordered offenders subject to forensic psychiatric assessment.[28-30]
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11
12 Another main finding was that violent offenders had nearly five times higher crude risk and non-
13
14 violent offenders more than two-fold higher risk for suicide compared to non-criminals. Even after
15
16 controlling for multiple confounders measured at conscription the hazard ratios remained
17
18 significant. Alcohol and substance misuse and attempted suicide in the fully adjusted model were
19
20 confounding on suicide and only association between non-violent offending and suicide remained
21
22 significant. This implies a strong association between these clinical predictors and suicide
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24 risk.[11,31] However, we do not have knowledge about the time order between criminality and the
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26 clinical factors measured during the follow-up period, why we have to take the results with
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28 cautions.
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31
32 There is some evidence in the literature that violent criminals have higher rates of suicide, but
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34 these numbers are often derived from prison populations with often difficult circumstances such as
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36 overcrowded cells and spaces.[32] Very few earlier studies on the association between violent and
37
38 non-violent criminality and suicide have been conducted in a cohort representing the general
39
40 population and with a long follow-up period. However, national data from England and Wales
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42 found after age standardization, 9- to 13-fold increased risk for suicide in both prisoners and non-
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44 custody offenders.[32]
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47
48 We found the suicide cases were rather equally distributed throughout the 35 years follow-up
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50 period which probably means that all age categories seem to be vulnerable for suicide. Other
51
52 studies have shown that the yearly incidence rates of suicide have not shown a clear decrease in
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54 the younger age categories in Sweden, why it is important to identify delinquency at young ages
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56 and other risk factors in order to find preventive strategies for this group.[5] Generally, suicide
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3 rates are higher among the older age groups, often due to loneliness, anxiety disorder and
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5 depression.[33-34]

6
7 Another finding was that poisoning as method of completed suicide was most prevalent in violent
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9 and non-violent criminals, while hanging was the most prevalent method among non-criminals.

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11 That was also the case for men in the whole of Sweden.[35] In a Danish national register study of
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13 9708 suicide cases and 188,134 age and gender matched living controls, hanging was the leading
14
15 suicide method among men, while poisoning among women.[36-37] One possible explanation to
16
17 the high prevalence of poisoning in criminals in our study could be that alcohol and substance use
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19 was more prevalent in the criminal groups including fatal and non-fatal poisonings compared to
20
21 non-criminals.
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24 25 **Suicide attempt and alcohol misuse**

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27 We found that one third of the violent offenders were already diagnosed at conscription with a
28
29 psychiatric diagnosis. Psychiatric disorders are strongly related to suicide risk, whereas the
30
31 association between mental illness and violent crime is not as evident. King and Barraclough [38]
32
33 found 27 times higher risk of unnatural death (suicide, accident and undetermined) among
34
35 individuals who had recently been in contact with psychiatric clinics compared to those who had
36
37 not. Persons with severe psychiatric disorders like affective disorder and schizophrenia have
38
39 highly elevated lifetime suicide risk.[39-40]
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42
43 One out of five suicide victims in this study had attempted suicide, confirming a strong association
44
45 between suicide attempt and suicide. This was especially evident for violent offenders where one
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47 in three had attempted suicide. Suicide attempt has been considered as one of the strongest
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49 predictors of suicide and the risk seem to be elevated up to older ages and during long time
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51 periods.[41] In the total cohort, we found that 1192 men (2.4%), had attempted suicide which
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53 could be considered as rather low frequency when comparing with the suicides (n=615). An
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55 American national study (National Survey on Drug Use and Health), based on interviews and
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3 web-questionnaires from 92,264 respondents in year 2008 and 2009, found one suicide case for
4 every 25 attempted suicides.[42] We had data on only suicide attempts needing inpatient care,
5 namely serious suicide attempts, which could explain the ratio. We did not have data on attempted
6 suicides that not turn up as hospital records. Some suicide attempters do not search help at any
7 care givers.[43-44]
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14 In the present study, about half of the violent offenders had reported either risky alcohol or
15 substance use at the time of conscription and nearly one third had been treated at hospital for an
16 alcohol related diagnosis. Alcohol misuse has also been pointed out as an important risk factor for
17 suicide and in some studies the second most common diagnostic group.[33,45] Wilcox et al.[16]
18 found alcohol misusers having a 10-fold increase risk for suicide in a mixed-age cohort. Likewise,
19 in a longitudinal cohort study by Flensburg-Madsen et al.[45] individuals with alcohol use
20 disorders had eight times higher hazard ratios of suicide compared to individuals with no alcohol
21 use. The hazard ratio fell to three after adjustment of psychiatric disorders. These findings indicate
22 the importance of early detection and prevention strategies and treatment for substance users and
23 especially those with suicidal tendencies in all ages.[34] The relationship between alcohol use and
24 violence seems to be complex.[46] The fact that the suicide rate is somewhat higher in the violent
25 criminals than non-violent criminals, one could assume that alcohol misuse play an important role
26 for both violence and suicide.[45]
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43 **Advantages and limitations**

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45 An advantage of this study is the large national cohort with a longitudinal design and with several
46 adolescent confounders. Only a small part 2-3 % of the conscripts was excluded from the study
47 mainly because of physical or psychiatric disorders. The two questionnaires used at conscription
48 were non-anonymous, which could have contributed to a lower response rate of especially
49 problematic issues such as alcohol and substance use. However, other studies on conscription
50 cohort have compared register and self-reported information of alcohol and substance use and
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3 found good agreement between the different sources of data. [24] A small number of the
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5 conscripts missed one or some of the items in the questionnaires. That was especially evident for
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7 those subjects who had committed violent offences whereas the response rate for the confounders
8
9 included in the study varied from 0.26 to 9.45%. The corresponding measures for other criminality
10
11 and non-criminals were: 0.20 to 6.37% and 0.13 to 4.19%. The violent offenders had probably
12
13 more severe risk factors than the non-violent and non-criminal groups which could have resulting
14
15 in underestimating of the hazard ratios of suicide. One could assume that these subjects also had
16
17 higher rates of substance use and other maladjusted behaviour measured at conscription which in
18
19 turn could have affected the outcome.[47] However, we have no reason to believe that the risk for
20
21 the outcome, suicide, has been considerable affected due the internal missing data.
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23

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25 Another limitation of this study is that we do not have information about criminality not turning
26
27 up in the register. Some subjects could have committed many violent and non-violent crimes,
28
29 especially in combination with substance misuse, and never been convicted of a crime.
30

31 **Conclusions**

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33 We found that individuals registered for either violent or other criminality are at increased risk for
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35 committing suicide and that is especially evident for those who were criminal repeaters. However,
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37 after adjusting for confounders measured at conscription the risk was still elevated and just
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39 slightly significant or non-significant in the fully adjusted model including hospitalization due to
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41 alcohol and substance misuse and suicide attempt. The two criminal groups were more likely to
42
43 use poisoning as suicide method indicating prior experiences of substance misuse. Hanging was
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45 most prevalent in the non-criminal group which is in line with the general population in Sweden.
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47 [35] We suggest that authorities and the health care should observe the increased risk for suicide
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49 in both violent and non-violent criminals, especially those with earlier suicide attempt and
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51 comorbid alcohol and substance misuse.
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18
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20
21 version of the manuscript. AS contributed to the planning and data analyses. JJ and AR
22
23 contributed to the planning of the study and preparing of the manuscript. All authors contributed
24
25 to the final draft of the manuscript.

26
27 **Ethics approval:** Regional ethical review board in Stockholm. (Dnr 2007/174-31, Dnr
28
29 2008/1086-31/5).

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31 **Data sharing:** No additional data available.

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38 **Figure legend:**

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40 Fig 1. Kaplan-Meier survival plot for suicide in violent and non-violent criminals
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Table 1. Baseline characteristics and hospitalization in relation to non-violent and violent criminality				
	No crime	Non-violent criminality	Violent criminality	Chisq, prob. **)
Fathers' social class				
III	15433 (47.67)	7146 (50.38)	1321(58.07)	
I-II	15680 (48.43)	6133 (43.24)	739(32.48)	204.72,p<0.0001
Missing *)	1262 (3.90)	904 (6.37)	215(9.45)	
Medication for nervous problems in the family				
Yes (parents or other family members)	9747(30.11)	4897(34.53)	918(40.35)	
No	21698(67.02)	8738(61.61)	1231(54.11)	201.34, p<0.0001
Missing	931(2.88)	548(3.86)	126(5.54)	
Conduct problems at school				
Yes (at least once)	5726 (17.69)	4743 (33.44)	1188 (52.22)	
No	26352 (81.39)	9226 (65.05)	1034 (45.45)	2470.41, p<0.0001
Missing	298 (0.92)	214 (1.51)	53(2.33)	
Taken medication for psychiatric problems				
Yes	3217(9.94)	1858(13.10)	456(20.04)	
No	28821(89.02)	12087(85.22)	1757(77.23)	293,35, p<0.0001

Missing	338(1.04)	238(1.68)	62(2.73)	
Emotional control				
Very bad, bad	8677 (26.8)	4941(34.84)	1135(49.89)	
Very good, good, medium	23471(72.6)	9094(64.12)	1097 (48.22)	769.81, p<0.0001
Missing	228(0.70)	148(1.04)	43(1.89)	
Intellectual capacity (IQ)				
Below average	5190 (16.03)	3296(23.24)	812(35.69)	
Above average, average	27145(83.84)	10859(76.56)	1457(64.04)	764.81,p<0.0001
Missing	41(0.13)	28(0.20)	6 (0.26)	
Psychiatric diagnosis (at conscriptioin)				
Yes (at least one diagnosis)	3151 (9.73)	2251 (15.87)	679 (29.85)	
No	28679 (88.58)	11639 (82.06)	1559 (68.53)	1008.59, p<0.0001
Missing	546 (1.69)	293 (2.07)	37(1.63)	
Contact with police and juvenile authorities				
Yes (several or some times)	6726 (20.77)	5585 (39.38)	1458 (64.09)	
No	25208 (77.86)	8314 (58.62)	754 (33.14)	3305.72, p<0.0001
Missing	442 (1.37)	284 (2.00)	63 (2.77)	
Risky alcohol use				
Yes	2683 (8.29)	2807(19.79)	901(39.60)	

No	29279(90.43)	11119(78.40)	1310(57.58)	2681.86, p<0.0001
Missing	414(1.28)	257(1.81)	64(2.91)	
Dug misuse				
Yes	585 (1.81)	919(6.48)	248(10.9)	
No	30410(94.00)	12533(88.37)	1864(81.93)	1063, 23, p<0.0001
Missing	1381(4.27)	731(5.15)	163(7.16)	
Sniffing				
At least once	3187(9.84)	2614(18.43)	673(29.58)	
No	28756(88.82)	11259(79.38)	1520(66.81)	1234.54, p<0.0001
Missing	433(1.34)	310(2.19)	82(3.60)	
Hospitalization				
Alcohol hospitalization				
Yes (at least once)	571(1.76)	1524(10.75)	727(31.96)	
No	31805(98.24)	12659(89.25)	1548(68.04)	4464.28, p<.00001
Drug use hospitalization				
Yes (at least once)	50,(0.15)	352(2.48)	265(11.65)	
No	32326(99.85)	13831(97.52)	2010(88.35)	2269.25, p<.00001
Hospitalization for suicide attempts				
Yes (at least once)	303(0.94)	581(4.10)	308 (13.54)	
No	32073(99.06)	13602(95.90)	1967(86.46)	1647.76, p<0.0001

*) No answers were given to this item

**) p-value calculated for non-missing observations

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Table 2. Suicide methods related to violent and non-violent criminality. Cox proportional regression analyses.		
Methods of suicide	Crime	HR , 95% CI
Poisoning (n=278): E950-E952, E980-E982, X60-X69, Y10-Y19	No crime	1.0
	Non-violent crime	2.94, 2.26-3.81
	Violent crime	6.92, 4.91-9.76
Hanging/suffocation (n=149): E953, E983, X70, Y20	No crime	1.0
	Non-violent crime	1.28, 0.90-1.83
	Violent crime	2.54, 1.47-4.40
Firearm (n=69): E955,E985, X722-X74, Y422-Y424	No crime	1.0
	Non-violent crime	1.39, 0.83-2.34
	Violent crime	3.08, 1.44-6.60
Drowning (n=41): E954, E984, X71,Y21	No crime	1.0
	Non-violent crime	1.62, 0.82-3.20
	Violent crime	5.17, 2.19-12.24
Jump from heights (n=27): E957, E987, X80, Y30	No crime	1.0
	Non-violent crime	3.23,1.43-7.26
	Violent crime	4.41, 1.21-16.00
Moving train (n=22): E9580, E9880, X81, Y31	No crime	1.0
	Non-violent crime	2.07, 0.84- 5.10
	Violent crime	4.40, 1.21- 15.98
Cutting (n=16): E956, E986,X79,Y28	No crime	1.0
	Non-violent crime	4.61, 1.58-13.50
	Violent crime	2.95, 0.35-25.23
Others (n=13): E958-959,E988-989, X75-X77, X79, X82-X84, Y425-Y27, Y29, Y32-Y34	No crime	1.0
	Non-violent crime	2.32, 0.67-8.01
	Violent crime	8.99, 2.15-37.63

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Table 3. Criminality in relation to suicide adjusted for early risk factors measured at conscription ¹⁾ and in addition adjusted for alcohol and drug inpatient and suicide attempt ²⁾ .					
Suicide					
N=615					
Criminality	No. of exposed	No. of cases	HR Crude	HR Adjusted ¹⁾	HR Adjusted ²⁾
Never	32376	275	1.0	1.0	1.0
Non-violent	14183	252	2.08, 1.72-2.52	1.65, 1.35- 2.01	1.35, 1.10- 1.67
Violent	2275	88	4.69, 3.56-6.19	2.68, 1.98-3.64	1.30, 0.92-1.82

¹⁾ adjusted for fathers' social class, medication for nervous problems in the family, conduct problems at school, own medication for psychiatric disorder, contact with police and juvenile authorities, emotional control, intellectual capacity, psychiatric diagnosis at conscription, sniffing of solvents, risky alcohol misuse and substance misuse. ²⁾ In addition adjusted for alcohol and drug inpatient and suicide attempt.

Table 4. Violent and non-violent offences and suicide. Bivariate and multivariate Cox proportional regression analyses.			
SuicideN=615			
Criminality	HR Crude	HR Adjusted ¹⁾	HR Adjusted ²⁾
Non-violent offence			
0 offence (n=32376, 66.30%)	1.0	1.0	1.0
1 offence (n=7322, 14.99%)	1.46, 1.15-1.85	1.25, 0.96-1.63	1.18, 0.91-1.55
2+ offences (n=9136, 18.71%)	3.27, 2.75-3.88	2.24, 1.81-2.77	1.49, 1.17-1.89
Violent offence			
0 offence (n=46559, 95.34%)	1.0	1.0	1.0
1 offence (n=1556, 3.19%)	2.65, 1.96-3.58	1.83, 1.29-2.59	1.17, 0.82-1.67
2+ offence (n=719, 1.47%)	5.40, 3.94-7.39	2.42, 1.61-2.59	0.84, 0.54-1.31

¹⁾ adjusted for fathers' social class, medication for nervous problems in the family, conduct problems at school, own medication for psychiatric disorder, contact with police and juvenile authorities, emotional control, intellectual capacity, psychiatric diagnosis at conscription, sniffing of solvents, risky alcohol misuse and substance misuse. ²⁾ In addition adjusted for alcohol and drug inpatient and suicide attempt.

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Criminality and Suicide—A longitudinal Swedish Cohort Study

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ABSTRACT

Objectives: This study aimed to investigate whether both violent and non-violent offending was related to elevated risk of suicide. We also investigated if the risk was higher among those with repeated offences and how experiences of substance abuse and suicide attempt modified the relationship.

Design: A nationwide prospective cohort study.

Setting: A register study of 49,398 conscripted men in 1969/70 in Sweden followed up during a 35-years period in official registers.

Participants: A Birth cohort of 49,398 men who were mandatory conscripted for military service in 1969/70 at age of 18-20 years. Possible confounders were retrieved from psychological assessments at conscription and the cohort was linked to mortality and hospitalization and crime records from 1970 and onwards. Estimates of suicide risks were calculated as hazard ratio (HR) with 95% confidence intervals (CI) using Cox proportional regression analyses with adjustment for potential confounding by family, psychological and behavioural factors including substance use and psychiatric disorders.

Results: Of the total cohort 2,671 (5.5%) persons died during the follow-up period. Of these 615 (23.6%) died due to suicide. Non-violent criminality was evident for 29.0% and violent criminality for 4.7% of all the participants. In the crude model, the violent offenders had nearly five times higher risk (HR=4.80, 3.73-6.19) to die from suicide and non-violent criminals about two (HR=2.14, 1.79-2.56). In the fully adjusted model the hazard ratios were still significant for suicide.

Conclusions: Experiences of violent or non-violent criminality were associated with increased risk of suicide. Co-morbidity with alcohol and substance use and psychiatric disorders modified the risk, but the suicide risk remained significantly elevated for non-violent criminals. It is crucial to identify offenders and especially repeated offenders who also suffer from alcohol or substance misuse and psychiatric illness in clinical settings in order to prevent suicide.

ARTICLE SUMMARY

Article focus

The aim of this cohort study was to analyse the association between violent and non-violent criminality and suicide in a large population based cohort of 49.398 18-20 years Swedish male conscripts followed-up for 35 years. Early confounders were collected through two questionnaires and interviews regarding psychosocial conditions including alcohol and substance use. Criminality, suicide attempt and suicide data were collected through official registers.

Key messages

- In Cox proportional regression analyses, the violent offenders had nearly five times higher hazard ratio to die from suicide and non-violent criminals about two. After controlling for early covariates, the hazard ratios still remained significant for suicide.
- Suicide attempt, severe alcohol and substance use measured at follow-up modified the risk of criminality on suicide.
- Poisoning as a suicide method was most prevalent in the criminal groups, while hanging in the non-criminals.

Strengths and limitations of this study

- The study is based on a large national cohort with a longitudinal design and with several adolescent confounders. Only a small part 2-3 % of the participants was excluded from the study mainly because of physical or psychiatric disorder/disability.
- This study adds knowledge about the association between violent and non-violent criminality and the risk of suicide.
- The limitations were that non-anonymous questionnaires were used, which may have contributed to a lower response rate of especially problematic issues such as alcohol and substance use, but the response rate was nevertheless high.

INTRODUCTION

Almost one million people worldwide die from suicide every year. Suicide was accounted for 1.8% of the total disease burden in 1998 and has been estimated to be 2.4% by 2020.[1] Further, suicide is one of the three leading causes of mortality in the age category 15-44 years and the second among those aged 15-19.[2]

Earlier studies on the relationship between criminality and suicide have been mostly conducted on populations in prison or newly released from prison.[3-6] Studies have found an elevated risk of 5 to 9 and in some studies much higher depending on the age group for suicide among prison inmates compared to the general population and more than a third of the male suicide cases had a history of criminality.[5-6]

Studies of suicide among offenders who are not in prisons are rather few, but an elevated risk in this population has also been reported.[7-8] Webb et al. examined suicide risk among people processed by Danish criminal justice system in a nested case-control study of 27,219 suicide cases and 524,899 matched living controls over 3 decades. More than one third of the male cases had a criminal history and when comparing with the general population custodial sentence, and psychiatric treatment and violent offences were important predictors for suicide.[5]

In a Swedish national cohort study of 992 881 young adults found that both female and male repeated offenders had a suicide risk of about six times higher than non-offenders. [9] Young female offenders had a risk of 3.7 and young male offenders had a risk of 3.0 after control for psychiatric in-patient care and for substance abuse until the end of the follow-up.[9]

A suicide attempt has been considered as the strongest predictor of the subsequent suicide. The suicide risk after an attempt was up to 40 times the expected rate[10] and lifetime prevalence suicide rates of suicide attempters with severe coexistent psychiatric disorder were even higher.

[11]

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3 In a Swedish national register based study, it was found that patients who had attempted suicide by
4 hanging evinced highest risk for suicide in one year after the attempt.[12]
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7 Studies on risk factors for suicide have stressed the importance of substance misuse for elevated
8 mortality rates.[13-14] In most studies suicide is far more prevalent in substance users than in the
9 general population. For instance, Darke et al.[15] found that about one third of the substance
10 misusers had experiences of suicide attempts. Suicide among opioid misusers has been estimated
11 to be 14 times higher than the general population.[10,16] Further, one fifth or more of the suicide
12 cases had substances presented in the blood in one study.[15]
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15 A previous study on the Swedish conscripts with a 13-years follow-up revealed that social and
16 behavioural factors and neurotic and personality disorder measured at conscription were most
17 significantly associated with high rate of suicide.[17] Likewise, a longitudinal study of offenders
18 and victims of violence and cause specific mortality showed that the hazard ratio for suicide risk
19 was about two after adjustment for various psychosocial confounders.[13]
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21
22 In this representative, nationwide, general population study we followed 49,398 Swedish
23 conscripts during 35 years, in order to examine whether violent and non-violent offending were
24 related to elevated risk of suicide. We also investigated if the risk was higher among those with
25 repeated offences and how substance abuse and suicide attempt history modified the relationship.
26 Moreover, we studied the choice of suicide methods for the violent and non-violent criminal
27 groups.
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31 This study aimed to address four main research questions:

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49 (1) Do conscripts with violent or non-violent criminality offences differ in respect to risk of
50 suicide?
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54 (2) Does suicide risk increase with repeated offences?
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3 (3) Does history of previous suicide attempt and/or serious substance and alcohol misuse modify
4 the relationship between violent and non-violent criminality on suicide?
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7 (4) Do methods of suicide differ between the criminal groups?
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10 11 MATERIAL AND METHODS

12 13 Participants

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16 This nationwide study is based on 49,398 18-20 years young Swedish men conscripted for
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18 military service from 1 July 1969 to 30 June 1970. About 2-3% was exempted from the military
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20 service mainly because of a physical or psychiatric disorder/disability. In order to get a
21
22 homogenous age group we included 48,411 conscripts born 1949 to 1951. Six per cent of the
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24 conscripts were born in 1949, 18 % in 1950 and 75 % in 1951. The mean age at the end of the
25
26 follow-up was about 53 years of age for the survivors.
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29 30 Measures

31 32 Measurement of potential confounders

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34 At conscription, each conscript was asked to answer two non-anonymous voluntary
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36 questionnaires. The first included questions about family and psychosocial background and
37
38 health. The second about substance use including alcohol and drug use and sniffing of solvents.
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40 Studies have shown that the questionnaires have been found to have sufficient validity for
41
42 epidemiological studies.[17-18]
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45 Besides the measures of substance use, the confounders were selected from the conscription data,
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47 based on the scientific studies and earlier studies of this cohort.[9,13,18-21]
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50 The confounders were: Father's occupation: social class I+II vs. social class III.

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52 Social class I includes proprietors, private entrepreneurs and high salaried employees in private
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54 entrepreneurs and high-income employees in private and public sectors, Social class II other
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56 incomes and small entrepreneurs, and social class III mainly blue-collar workers.[22]
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3 Medication for nervous problems among parents or other members in the family (yes, at least one
4 parent or family member vs. no). Conduct problems at school (at least once vs. no). Any prior
5 contact with police and juvenile authorities (yes at least once vs. no). Having taken medication for
6 psychiatric disorder (at least once vs. no).
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11 The psychological variables were: Emotional control and intellectual capacity were assessed by
12 trained military psychologist who performed a structured interview with all conscripts. The
13 psychologists used both questionnaire and interview data and the measures were assessed on a 5-
14 point Likert scale. The ratings were regularly checked for interrater reliability, which was
15 satisfactory.[23] If the psychologist discovered or the conscript reported any psychiatric disorder,
16 the subject was referred to a psychiatrist and an eventual diagnosis was coded according to ICD-
17 8.[17, 23] Details of this procedure and the validity of the assessments have been described
18 earlier.[17, 23-25]
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29 Intellectual capacity (IQ) was based on four main intellectual and cognitive tests, measuring
30 verbal, logical-inductive, spatial, and technical and mechanical ability. The results of the tests
31 were aggregated in a 5-point summary score for overall intelligence, as described in detail by
32 Ståhlberg[26] and David et al.[27] These scale of intelligence capacity was scored 1=very bad;
33 2=bad; 3=moderate; 4=good; 5=very good and expressed as intelligence (1–3 vs. 4–5). Details of
34 this procedure and the validity of the assessments have been described by Otto.[23]
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43 Problematic alcohol use was dichotomized (yes vs. no, with yes defined as one or more of
44 consumption of ≥ 210 g pure alcohol per week, having ever taken an ‘eye-opener’, being
45 intoxicated often, having been taking into custody for public drunkenness on at least one
46 occasion, and non-prescription drug (ever vs. never). Drug misuse was coded (yes vs. no), with
47 yes defined as used illicit drugs 10 times or more or any intravenous drug use.
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54 **Measures of alcohol and drug misuse and suicide attempt**

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3 Data from the National Swedish inpatient register were used to identify inpatient care with an
4 alcohol or drug diagnosis of dependence or abuse according to ICD-8 and ICD-9 from 1987 and
5 ICD-10 from 1997 onwards.
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9 The register includes details concerning inpatient care stays and days at hospital and diagnoses,
10 and has covered all public hospitals in Stockholm and Uppsala County since 1972, 85% of all
11 Swedish public inpatient care stays since 1983, and about 98–99% since 1987. The ICD
12 classifications for hospitalization and mortality were: Drug misuse – ICD-8: 304 and 965.0; ICD-
13 9: 304, 965A, 968F, 969G and 969H; and ICD-10: F11-12, F14, F15, F16, F18, F19, O35.5,
14 P04.4, T40.0–T40.3, T40.5–T40.9, T43.6, Z71.5, and X42. Alcohol misuse – ICD-8: 291, 303,
15 571.00, 571.01 and 980; ICD-9: 291, 303, 305A, 357F, 425F, 535D, 571A–571D and 980; and
16 ICD-10: E24.4, F10, G31.2, G62.1, G72.1, I42.6, K29.2, K70, K86.0, O35.4, P04.3, Q86.0, T51,
17 X45, Y91, Z50.2 and Z71.4. Suicide attempt: ICD-8 and ICD- 9: Determined suicide attempt:
18 E950-E959 and undetermined E980-E989; ICD-10: Determined X60-X84 and undetermined
19 suicide attempt: Y10-Y34.
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34 **Suicide**

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36 Information about suicide was obtained from Cause of Death Register which provides mortality
37 data and covers more than 99% of all deaths occurring in Sweden and is based on information
38 from death certificates. Suicide was classified according to ICD-8 and ICD-9: E950-E959 and
39 ICD-10: X60-X84 or as death with undetermined intent ICD-8 and ICD-9: E980-E989 and ICD-
40 10: Y10-Y34. The same ICD-codes as for the hospital register.
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47 **Measurement of crime**

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49 Data from the National Crime Register were used to identify date, type, and number of criminal
50 offenses. The Crime Register contains information on all convictions in Sweden from 1966 and
51 onwards. Criminality was divided in three categories: no crime, violent crime and non-violent
52 crime. Violence was defined as: homicide, manslaughter and assault and non-violent crime all the
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3 other convictions. We also categorized the cohort according to number of crimes meaning for
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5 violent and non-violent offenders: (0, 1, and 2 or more crimes).

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7 Information about alcohol and drug inpatient-care, criminality and suicide was linked at
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9 Statistics Sweden (Statistiska Centralbyrån) via the unique personal number for each individual in
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11 the cohort. This personal number was then replaced with an individual serial number making the
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13 data anonymous to the research group, after approval of Regional ethical review board in
14
15 Stockholm.

16 17 18 **Statistical analyses**

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20 Cox proportional bivariate and multivariate regression analysis was used to calculate hazard ratios
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22 (HRs) with 95% confidence intervals (95% CI) for violent and non-violent criminality and
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24 suicide. We adjusted for confounders measured at conscription in relation to time to suicide. The
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26 surveillance time was calculated from September 1969 until death or until 31 December 2004 for
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28 all subjects in the cohort.

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30 We had no exact information whether a person had emigrated from Sweden or not during the
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32 follow-up period, therefore we could not censor for emigration in the calculation of person time.

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34 In order to investigate the association between the number of criminal offences and mortality, we
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36 categorized subjects according to committed numbers of offences (0, 1, 2 and more) in relation to
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38 the time to suicide by using Cox proportional regression analysis. These were measured at the
39
40 time of conscription and only measured once why the time order was difficult to prove. Some of
41
42 these variables like alcohol- or substance use could act as confounders or mediators on both
43
44 criminality and suicide.

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46 A test of the proportional hazard assumption was performed for each confounder (X) in bivariate
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48 and multivariate analyses by using a time-dependent explanatory variable in the model ($X \cdot (\log$
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50 $\text{time} - \text{average value of the log time})$). If the p-value was significant ($p < .05$) the proportional
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52 hazard assumption was not fulfilled and the variable was not included in the analyses.
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5 We used Kaplan-Meier survival curves to plot survival probability of suicide in non-criminals,
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7 violence and other criminality during the 35 years follow-up.
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10 Chi-square (X^2) test was used when calculating early confounders and hospitalization in relation
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12 to criminality.
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14 15 16 **RESULTS**

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18 Of the total cohort, 2,671 subjects (5.5%) died during the follow-up period. Of these 615 (23.6%)
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20 died due to suicide (474 determined and 141 undetermined). Suicide was more prevalent in the
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22 criminal groups: no criminality (4.11%), non-violent (7.3%) and violent criminality (13.7%).
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25 The suicide cases were rather equally distributed throughout the 35 years follow-up period.
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28 More than one third (34%) of the suicide cases were 30 years or younger, 30% were in the age
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30 category 31-40 years and the remaining subjects (36%) were 41 years or older. The mean age was 36
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32 years.
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35 Table 1 shows the distribution of 11 confounders measured at conscription divided into the three
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37 groups of criminals. All risk factors differed significantly ($p < 0.0001$) between the groups, but mostly
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39 prior contact with the police or juvenile authorities, and having had conducted problems at school.
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42 Regarding hospitalization of alcohol or drug misuse which had occurred during the follow-up period,
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44 alcohol misuse differed most significantly between the groups.
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46 **Methods of suicide**

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48 Poisoning was the most prevalent method of suicide ($n=278$) followed by hanging and suffocation
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50 ($n=149$) (Table 2). The violent offenders had nearly seven times higher hazard to die from poisoning
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52 ($HR=6.92$, 95%CI 4.91-9.76), while the non-violent criminal group had almost three times higher
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54 risk ($HR=2.94$, 95%CI 2.26-3.81). The violent group had three times higher hazard ratio to die due to
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56 shooting by firearm, while the non-violent group had no significant risk.
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Crude and multivariate analyses

Violent related criminality had the highest hazard ratio for suicide (HR=4.69, 95%CI 3.56-6.19) followed by non-violent criminality (HR=2.08, 95%CI 1.72-2.52) in bivariate analyses. After adjustment for multiple confounders, the hazard ratios decreased to nearly three (HR=2.68) and two fold (HR=1.65) respectively (Table 3). Four out of 11 of the confounders in the model e.g. low emotional control (HR=1.4), low intellectual capacity (1.36), own medication for psychiatric problems (HR=1.40) and medication for nervous problem in the family (HR=1.23) were significantly associated with suicide. In the fully adjusted model we also included alcohol and drug inpatient care stays and suicide attempt and found elevated hazard ratios, however, only significant in non-violent offenders (HR=1.35, 95%CI 1.10-1.67). All these three inpatient-care variables were associated with suicide: suicide attempt carried an hazard of 4.83, while alcohol and drug misuse had lower hazards (2.00 and 1.74, respectively).

Repeated violent and non-violent offenders in relation to suicide

Both repeated non-violent and violent offences were associated with elevated hazard ratios of suicide in crude analyses (HR=3.27 and HR=5.40). When adjusted for early confounders the repeaters of both violent and non-violent offenders decreased to HRs=2.42 and 2.24, respectively (Table 4).

We conducted Kaplan-Meier survival distribution curves for the three criminal groups in relation to suicide from 1970 up to 2004. We found that violent criminality was associated with lower survival (Fig 1).

DISCUSSION

One aim of this study was to analyse the association between male violent and non-violent offending and risk for suicide in a population-based cohort during a 35-years follow-up.

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3 A main finding was that nearly one third of the death cases were due to suicide in those who had
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5 ever committed a violent offence and one fourth in the non-violent group. This is in line with
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7 earlier studies reporting high proportionate mortality among homicide offenders and among
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9 personality-disordered offenders subject to forensic psychiatric assessment.[28-30]
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12 Another main finding was that violent offenders had nearly five times higher crude risk and non-
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14 violent offenders more than two-fold higher risk for suicide compared to non-criminals. Even after
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16 controlling for multiple confounders measured at conscription the hazard ratios remained
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18 significant. Alcohol and substance misuse and attempted suicide in the fully adjusted model were
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20 confounding on suicide and only association between non-violent offending and suicide remained
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22 significant. This implies a strong association between these clinical predictors and suicide
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24 risk.[11,31] However, we do not have knowledge about the time order between criminality and the
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26 clinical factors measured during the follow-up period, why we have to take the results with
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28 cautions.
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32 There is some evidence in the literature that violent criminals have higher rates of suicide, but
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34 these numbers are often derived from prison populations with often difficult circumstances such as
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36 overcrowded cells and spaces.[32] Very few earlier studies on the association between violent and
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38 non-violent criminality and suicide have been conducted in a cohort representing the general
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40 population and with a long follow-up period. However, national data from England and Wales
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42 found after age standardization, 9- to 13-fold increased risk for suicide in both prisoners and non-
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44 custody offenders.[32]
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48 We found the suicide cases were rather equally distributed throughout the 35 years follow-up
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50 period which probably means that all age categories seem to be vulnerable for suicide. Other
51
52 studies have shown that the yearly incidence rates of suicide have not shown a clear decrease in
53
54 the younger age categories in Sweden, why it is important to identify delinquency at young ages
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56 and other risk factors in order to find preventive strategies for this group.[5] Generally, suicide
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3 rates are higher among the older age groups, often due to loneliness, anxiety disorder and
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5 depression.[33-34]

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7 Another finding was that poisoning as method of completed suicide was most prevalent in violent
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9 and non-violent criminals, while hanging was the most prevalent method among non-criminals.

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11 That was also the case for men in the whole of Sweden.[35] In a Danish national register study of
12
13 9708 suicide cases and 188,134 age and gender matched living controls, hanging was the leading
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15 suicide method among men, while poisoning among women.[36-37] One possible explanation to
16
17 the high prevalence of poisoning in criminals in our study could be that alcohol and substance use
18
19 was more prevalent in the criminal groups including fatal and non-fatal poisonings compared to
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21 non-criminals.
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24 25 **Suicide attempt and alcohol misuse**

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27 We found that one third of the violent offenders were already diagnosed at conscription with a
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29 psychiatric diagnosis. Psychiatric disorders are strongly related to suicide risk, whereas the
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31 association between mental illness and violent crime is not as evident. King and Barraclough [38]
32
33 found 27 times higher risk of unnatural death (suicide, accident and undetermined) among
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35 individuals who had recently been in contact with psychiatric clinics compared to those who had
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37 not. Persons with severe psychiatric disorders like affective disorder and schizophrenia have
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39 highly elevated lifetime suicide risk.[39-40]
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43 One out of five suicide victims in this study had attempted suicide, confirming a strong association
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45 between suicide attempt and suicide. This was especially evident for violent offenders where one
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47 in three had attempted suicide. Suicide attempt has been considered as one of the strongest
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49 predictors of suicide and the risk seem to be elevated up to older ages and during long time
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51 periods.[41] In the total cohort, we found that 1192 men (2.4%), had attempted suicide which
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53 could be considered as rather low frequency when comparing with the suicides (n=615). An
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55 American national study (National Survey on Drug Use and Health), based on interviews and
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3 web-questionnaires from 92,264 respondents in year 2008 and 2009, found one suicide case for
4 every 25 attempted suicides.[42] We had data on only suicide attempts needing inpatient care,
5 namely serious suicide attempts, which could explain the ratio. We did not have data on attempted
6 suicides that not turn up as hospital records. Some suicide attempters do not search help at any
7 care givers.[43-44]
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14 In the present study, about half of the violent offenders had reported either risky alcohol or
15 substance use at the time of conscription and nearly one third had been treated at hospital for an
16 alcohol related diagnosis. Alcohol misuse has also been pointed out as an important risk factor for
17 suicide and in some studies the second most common diagnostic group.[33,45] Wilcox et al.[16]
18 found alcohol misusers having a 10-fold increase risk for suicide in a mixed-age cohort. Likewise,
19 in a longitudinal cohort study by Flensburg-Madsen et al.[45] individuals with alcohol use
20 disorders had eight times higher hazard ratios of suicide compared to individuals with no alcohol
21 use. The hazard ratio fell to three after adjustment of psychiatric disorders. These findings indicate
22 the importance of early detection and prevention strategies and treatment for substance users and
23 especially those with suicidal tendencies in all ages.[34] The relationship between alcohol use and
24 violence seems to be complex.[46] The fact that the suicide rate is somewhat higher in the violent
25 criminals than non-violent criminals, one could assume that alcohol misuse play an important role
26 for both violence and suicide.[45]
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43 **Advantages and limitations**

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45 An advantage of this study is the large national cohort with a longitudinal design and with several
46 adolescent confounders. Only a small part 2-3 % of the conscripts was excluded from the study
47 mainly because of physical or psychiatric disorders. The two questionnaires used at conscription
48 were non-anonymous, which could have contributed to a lower response rate of especially
49 problematic issues such as alcohol and substance use. However, other studies on conscription
50 cohort have compared register and self-reported information of alcohol and substance use and
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3 found good agreement between the different sources of data. [24] A small number of the
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5 conscripts missed one or some of the items in the questionnaires. That was especially evident for
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7 those subjects who had committed violent offences whereas the response rate for the confounders
8
9 included in the study varied from 0.26 to 9.45%. The corresponding measures for other criminality
10
11 and non-criminals were: 0.20 to 6.37% and 0.13 to 4.19%. The violent offenders had probably
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13 more severe risk factors than the non-violent and non-criminal groups which could have resulting
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15 in underestimating of the hazard ratios of suicide. One could assume that these subjects also had
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17 higher rates of substance use and other maladjusted behaviour measured at conscription which in
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19 turn could have affected the outcome.[47] However, we have no reason to believe that the risk for
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21 the outcome, suicide, has been considerable affected due the internal missing data.
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25 Another limitation of this study is that we do not have information about criminality not turning
26
27 up in the register. Some subjects could have committed many violent and non-violent crimes,
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29 especially in combination with substance misuse, and never been convicted of a crime.
30

31 **Conclusions**

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33 We found that individuals registered for either violent or other criminality are at increased risk for
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35 committing suicide and that is especially evident for those who were criminal repeaters. However,
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37 after adjusting for confounders measured at conscription the risk was still elevated and just
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39 slightly significant or non-significant in the fully adjusted model including hospitalization due to
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41 alcohol and substance misuse and suicide attempt. The two criminal groups were more likely to
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43 use poisoning as suicide method indicating prior experiences of substance misuse. Hanging was
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45 most prevalent in the non-criminal group which is in line with the general population in Sweden.
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47 [35] We suggest that authorities and the health care should observe the increased risk for suicide
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49 in both violent and non-violent criminals, especially those with earlier suicide attempt and
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51 comorbid alcohol and substance misuse.
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18
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21 version of the manuscript. AS contributed to the planning and data analyses. JJ and AR
22
23 contributed to the planning of the study and preparing of the manuscript. All authors contributed
24
25 to the final draft of the manuscript.

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27 **Ethics approval:** Regional ethical review board in Stockholm. (Dnr 2007/174-31, Dnr
28
29 2008/1086-31/5).

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Table 1. Baseline characteristics and hospitalization in relation to non-violent and violent criminality

	No crime	Non-violent criminality	Violent criminality	Chisq, prob. **)
Fathers' social class				
III	15433 (47.67)	7146 (50.38)	1321(58.07)	
I-II	15680 (48.43)	6133 (43.24)	739(32.48)	204.72,p<0.0001
Missing *)	1262 (3.90)	904 (6.37)	215(9.45)	
Medication for nervous problems in the family				
Yes (parents or other family members)	9747(30.11)	4897(34.53)	918(40.35)	
No	21698(67.02)	8738(61.61)	1231(54.11)	201.34, p<0.0001
Missing	931(2.88)	548(3.86)	126(5.54)	
Conduct problems at school				
Yes (at least once)	5726 (17.69)	4743 (33.44)	1188 (52.22)	
No	26352 (81.39)	9226 (65.05)	1034 (45.45)	2470.41, p<0.0001
Missing	298 (0.92)	214 (1.51)	53(2.33)	
Taken medication for psychiatric problems				
Yes	3217(9.94)	1858(13.10)	456(20.04)	
No	28821(89.02)	12087(85.22)	1757(77.23)	293,35, p<0.0001

Missing	338(1.04)	238(1.68)	62(2.73)	
Emotional control				
Very bad, bad	8677 (26.8)	4941(34.84)	1135(49.89)	
Very good, good, medium	23471(72.6)	9094(64.12)	1097 (48.22)	769.81, p<0.0001
Missing	228(0.70)	148(1.04)	43(1.89)	
Intellectual capacity (IQ)				
Below average	5190 (16.03)	3296(23.24)	812(35.69)	
Above average, average	27145(83.84)	10859(76.56)	1457(64.04)	764.81,p<0.0001
Missing	41(0.13)	28(0.20)	6 (0.26)	
Psychiatric diagnosis (at conscriptioin)				
Yes (at least one diagnosis)	3151 (9.73)	2251 (15.87)	679 (29.85)	
No	28679 (88.58)	11639 (82.06)	1559 (68.53)	1008.59, p<0.0001
Missing	546 (1.69)	293 (2.07)	37(1.63)	
Contact with police and juvenile authorities				
Yes (several or some times)	6726 (20.77)	5585 (39.38)	1458 (64.09)	
No	25208 (77.86)	8314 (58.62)	754 (33.14)	3305.72, p<0.0001
Missing	442 (1.37)	284 (2.00)	63 (2.77)	
Risky alcohol use				
Yes	2683 (8.29)	2807(19.79)	901(39.60)	

No	29279(90.43)	11119(78.40)	1310(57.58)	2681.86, p<0.0001
Missing	414(1.28)	257(1.81)	64(2.91)	
Dug misuse				
Yes	585 (1.81)	919(6.48)	248(10.9)	
No	30410(94.00)	12533(88.37)	1864(81.93)	1063, 23, p<0.0001
Missing	1381(4.27)	731(5.15)	163(7.16)	
Sniffing				
At least once	3187(9.84)	2614(18.43)	673(29.58)	
No	28756(88.82)	11259(79.38)	1520(66.81)	1234.54, p<0.0001
Missing	433(1.34)	310(2.19)	82(3.60)	
Hospitalization				
Alcohol hospitalization				
Yes (at least once)	571(1.76)	1524(10.75)	727(31.96)	
No	31805(98.24)	12659(89.25)	1548(68.04)	4464.28, p<.00001
Drug use hospitalization				
Yes (at least once)	50,(0.15)	352(2.48)	265(11.65)	
No	32326(99.85)	13831(97.52)	2010(88.35)	2269.25, p<.00001
Hospitalization for suicide attempts				
Yes (at least once)	303(0.94)	581(4.10)	308 (13.54)	
No	32073(99.06)	13602(95.90)	1967(86.46)	1647.76, p<0.0001

*) No answers were given to this item

**) p-value calculated for non-missing observations

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Table 2. Suicide methods related to violent and non-violent criminality. Cox proportional regression analyses.		
Methods of suicide	Crime	HR , 95% CI
Poisoning (n=278): E950-E952, E980-E982, X60-X69, Y10-Y19	No crime	1.0
	Non-violent crime	2.94, 2.26-3.81
	Violent crime	6.92, 4.91-9.76
Hanging/suffocation (n=149): E953, E983, X70, Y20	No crime	1.0
	Non-violent crime	1.28, 0.90-1.83
	Violent crime	2.54, 1.47-4.40
Firearm (n=69): E955,E985, X722-X74, Y422-Y424	No crime	1.0
	Non-violent crime	1.39, 0.83-2.34
	Violent crime	3.08, 1.44-6.60
Drowning (n=41): E954, E984, X71,Y21	No crime	1.0
	Non-violent crime	1.62, 0.82-3.20
	Violent crime	5.17, 2.19-12.24
Jump from heights (n=27): E957, E987, X80, Y30	No crime	1.0
	Non-violent crime	3.23, 1.43-7.26
	Violent crime	4.41, 1.21-16.00
Moving train (n=22): E9580, E9880, X81, Y31	No crime	1.0
	Non-violent crime	2.07, 0.84- 5.10
	Violent crime	4.40, 1.21- 15.98
Cutting (n=16): E956, E986,X79,Y28	No crime	1.0
	Non-violent crime	4.61, 1.58-13.50
	Violent crime	2.95, 0.35-25.23
Others (n=13): E958-959,E988-989, X75-X77, X79, X82-X84, Y425-Y27, Y29, Y32-Y34	No crime	1.0
	Non-violent crime	2.32, 0.67-8.01
	Violent crime	8.99, 2.15-37.63

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Table 3. Criminality in relation to suicide adjusted for early risk factors measured at conscription ¹⁾ and in addition adjusted for alcohol and drug inpatient and suicide attempt ²⁾ .					
Suicide					
N=615					
Criminality	No. of exposed	No. of cases	HR Crude	HR Adjusted ¹⁾	HR Adjusted ²⁾
Never	32376	275	1.0	1.0	1.0
Non-violent	14183	252	2.08, 1.72-2.52	1.65, 1.35- 2.01	1.35, 1.10- 1.67
Violent	2275	88	4.69, 3.56-6.19	2.68, 1.98-3.64	1.30, 0.92-1.82

¹⁾ adjusted for fathers' social class, medication for nervous problems in the family, conduct problems at school, own medication for psychiatric disorder, contact with police and juvenile authorities, emotional control, intellectual capacity, psychiatric diagnosis at conscription, sniffing of solvents, risky alcohol misuse and substance misuse. ²⁾ In addition adjusted for alcohol and drug inpatient and suicide attempt.

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Table 4. Violent and non-violent offences and suicide. Bivariate and multivariate Cox proportional regression analyses.			
SuicideN=615			
Criminality	HR Crude	HR Adjusted ¹⁾	HR Adjusted ²⁾
Non-violent offence			
0 offence (n=32376, 66.30%)	1.0	1.0	1.0
1 offence (n=7322, 14.99%)	1.46, 1.15-1.85	1.25, 0.96-1.63	1.18, 0.91-1.55
2+ offences (n=9136, 18.71%)	3.27, 2.75-3.88	2.24, 1.81-2.77	1.49, 1.17-1.89
Violent offence	HR Crude	HR Adjusted ¹⁾	HR Adjusted ²⁾
0 offence (n=46559, 95.34%)	1.0	1.0	1.0
1 offence (n=1556, 3.19%)	2.65, 1.96-3.58	1.83, 1.29-2.59	1.17, 0.82-1.67
2+ offence (n=719, 1.47%)	5.40, 3.94-7.39	2.42, 1.61-2.59	0.84, 0.54-1.31

47 ¹⁾ adjusted for fathers' social class, medication for nervous problems in the family, conduct
48 problems at school, own medication for psychiatric disorder, contact with police and juvenile
49 authorities, emotional control, intellectual capacity, psychiatric diagnosis at conscription, sniffing
50 of solvents, risky alcohol misuse and substance misuse. ²⁾ In addition adjusted for alcohol and
51 drug inpatient and suicide attempt.
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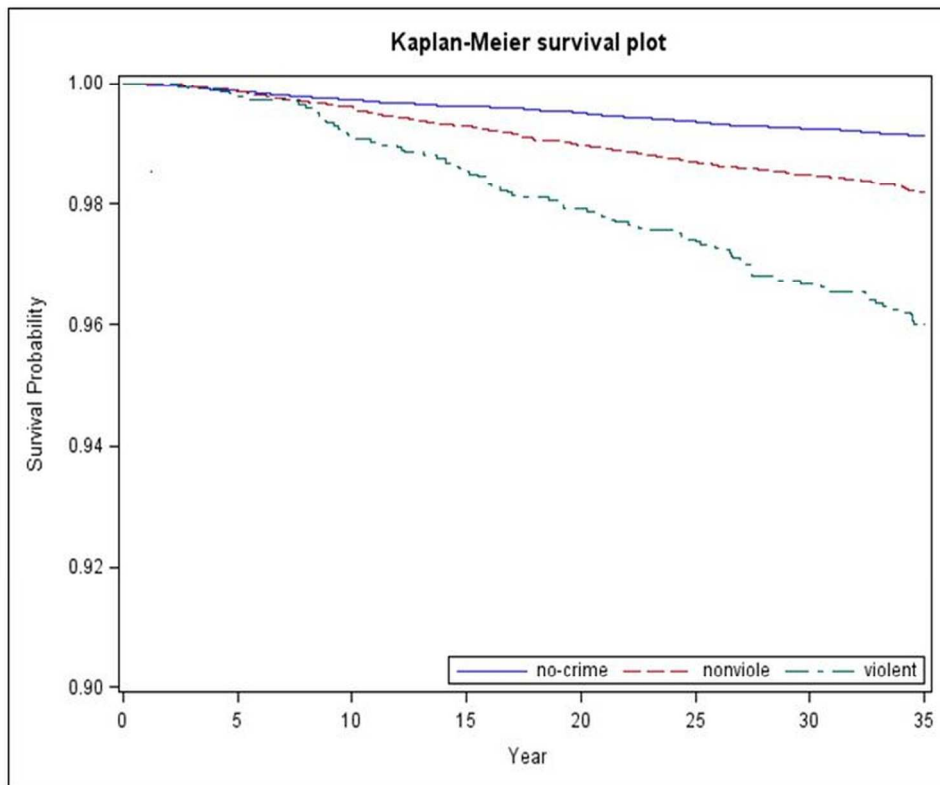


Fig 1. Kaplan-Meier survival plot for suicide in violent and non-violent criminals

101x90mm (300 x 300 DPI)

only

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	5
		(b) For matched studies, give matching criteria and number of exposed and unexposed	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6-8
Bias	9	Describe any efforts to address potential sources of bias	5,14
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	8
		(b) Describe any methods used to examine subgroups and interactions	8-9
		(c) Explain how missing data were addressed	14-15,22
		(d) If applicable, explain how loss to follow-up was addressed	8-9
		(e) Describe any sensitivity analyses	9
Results			14-15

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed (b) Give reasons for non-participation at each stage (c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (b) Indicate number of participants with missing data for each variable of interest (c) Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	Report numbers of outcome events or summary measures over time	8-9
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	9-11, 22-26
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	11
Limitations			14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	11-14
Generalisability	21	Discuss the generalisability (external validity) of the study results	
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	11

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

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