BMJ open

Criminality and Suicide – A longitudinal Swedish Cohort Study

Journal:	*BMJ Open*
Manuscript ID:	bmjopen-2013-003497
Article Type:	Research
Date Submitted by the Author:	01-Jul-2013
Complete List of Authors:	Stenbacka, Marlene; Karolinska Institute, Public Health Sidorchuk, Anna; Karolinska Institute, Public Health Sciences Romelsjö, Anders; Karolinska Institute, Public Health Sciences Jokinen, Jussi; Karolinska Institute, Clinical Neuroscience
Primary Subject Heading:	Epidemiology
Secondary Subject Heading:	Public health, Mental health, Epidemiology, Addiction
Keywords:	EPIDEMIOLOGY, Substance misuse < PSYCHIATRY, Suicide & self-harm < PSYCHIATRY, PUBLIC HEALTH

SCHOLARONE™
Manuscripts

For peer review only

Criminality and Suicide – A longitudinal Swedish Cohort Study

Stenbacka M.,1,2) Sidorchuk A.,2) Romelsjö A.,2) Jokinen J.3)

1). Addiction Center Stockholm, S:t Eriks Hospital Polhemsgatan 60, 112 82 Stockholm, Sweden.

2). Department of Public Health Sciences, Karolinska Institute, Widerströmska Building, 171 76 Stockholm, Sweden.

3). Department of Clinical Neuroscience, Karolinska Institute, Karolinska University Hospital Solna, 171 76 Stockholm, Sweden.

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

Word count: 3722 words

For peer review only

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.

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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.

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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].

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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 significantly associated with high rate of suicide[17]. Likewise, in a recent longitudinal study of the association between offenders and victims of violence and cause specific mortality found that suicide carried a hazard of about two after adjustment for various psychosocial covariates[13]. In this representative, nationwide, general population study we followed 49,398 Swedish conscripts during 35 years, in order to examine whether both violent and non-violent offending were related to elevated risk of suicide mortality. We also investigated if the risk is higher among those with repeated offences and how experiences of substance abuse and suicide attempt modified the relationship.

This study aimed to address three main research questions:
(1) Do conscripts with violent or non-violent criminality differ in respect to hazards of suicide mortality?
(2) Do suicide risk increase with repeated offences?
(3) Do history of previous suicide attempt and/or serious substance and alcohol misuse modify the relationship between violent and non-violent criminality on suicide mortality?
(4) Do methods of suicide differ between the criminal groups?

MATERIAL AND METHODS

Participants

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

Measures

Measurement of crime

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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

Measurement of potential confounders

Two non-anonymous questionnaires were used at the time of conscription. The first included questions about family and psychosocial background and health. The second about substance use including alcohol and drug use and sniffing of solvents. Studies have shown that the questionnaires have been found to have sufficient validity for epidemiological studies[17-18]. The included variables were family, behavioural, and psychological and health conditions measured at conscription.

The selection of variables was based on earlier research[13,18-21] and other studies of risk factors for criminality and suicide mortality[9]. We included 11 covariates which have proved to be significant in the bivariate Cox proportional regression analysis.

The covariates were: fathers' social class (social class III vs. I-II), and medication for nervous problems among parents or other members in the family (yes, at least one parent or family member vs. no) conduct problems at school (at least once vs. no), any prior contact with police and juvenile authorities (yes at least once vs. no), having taken medication for psychiatric disorder (at least once vs. no).The psychological variables, emotional control and intellectual capacity, were assessed by trained military psychologist who performed a structured interview with all conscripts. The psychologists combined questionnaire and interview data and the measures were assessed on a 5-point Likert scale. The ratings were regularly checked for

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

interrater reliability, which was satisfactory[22]. If the psychologist discovered or the conscript reported any psychiatric disorder, the subject was referred to a psychiatrist and an eventual diagnosis was coded according to ICD-8[17, 22]. Details of this procedure and the validity of the assessments have been described earlier[17, 23-24].

The intelligence scores were based on four main intellectual and cognitive tests, measuring verbal, logical-inductive, spatial, and technical and mechanical ability. The results of the tests were aggregated in a 5-point summary score for overall intelligence, as described in detail by Ståhlberg[25] and David et al[26]. These scale of intelligence capacity was scored 1=very bad; 2=bad; 3=moderate; 4=good; 5=very good and expressed as intelligence (1–3 vs. 4–5). Details of this procedure and the validity of the assessments have been described by Otto[22].
Problematic alcohol use was dichotomized (yes vs. no, with yes defined as one or more of consumption of ≥210 g pure alcohol per week, having ever taken an 'eye-opener', being intoxicated often, having been taking into custody for public drunkenness on at least one occasion, and non-prescription drug (ever vs. never). Drug misuse was coded (yes vs. no), with yes defined as used illicit drugs 10 times or more or any intravenous drug use.
Additionally, we included three variables regarding hospitalizations (alcohol and drug misuse and attempted suicide) during the follow-up period.

The cohort was followed through official registers and was linked at Statistics Sweden via the unique personal number for each individual, which thereafter was replaced with an individual serial number making the data anonymous to the research group, after approval of Karolinska Institute Research Ethics Committee (Dnr 2007/174-31, Dnr 2008/1086-31/5).

Measures of alcohol and drug misuse and suicide attempt

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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

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

Suicide mortality

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

Statistical analyses

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

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

We had no exact information whether a person had emigrated from Sweden or not during the follow-up period, while we could not censor for emigration in the calculation of person time. In order to investigate the association between the quantity of criminal offences and mortality, we categorized subjects according to committed numbers of offences (0, 1, 2 and more) in relation to the time to suicide mortality by using Cox proportional regression analysis with 95 % confidence intervals (95% CI). We adjusted for potential risk 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 mortality.

A test of the proportional hazard assumption was performed for each covariate 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 mortality in non-criminals, violence and other criminality during the 35 years follow-up.

Chi-squared (X^2) test was used when calculating early covariates and hospitalization in relation to criminality (Table 1).

Sensitivity analysis

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

RESULTS

Of the total cohort, 2,671 (5.5%) died during the follow-up period. Of these 615 (23.6%) died due to suicide. The suicide cases were rather equally distributed during the follow-up. More than one third

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

(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

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Both repeated non-violent and violent offences were associated with elevated hazards of suicide in crude analyses (HR=3.27 and HR=5.40). When adjusted for early covariates the repeaters of both violent and non-violent offenders decreased to HRs =2.42 and 2.34, respectively (Table 3).

We conducted Kaplan-Meier survival distribution curves for the three criminal groups in relation to suicide mortality from 1970 up to 2004. We found that violent criminality were associated with lower survival than the other two criminal groups (violent and non-violent offenders and no offenders) (Fig 1).

DISCUSSION

This study aimed to analyse suicide mortality in three groups of criminals: non-criminal, violent and non-violent criminal offenders. Very few earlier studies on the association between violent and non-violent criminality and suicide have been conducted in a cohort representing the general population and with a long follow-up period.

Nearly one third of the death cases were due to suicide in those who had ever committed a violent offence and one fourth in the non-violent group, which is in line with earlier studies reporting high proportionate mortality (the percentage of the dead who died by suicide) among homicide offenders and among personality-disordered offenders subject to forensic psychiatric assessment [27-28]. Likewise, the survival for the violent criminals was lower than the other two groups.

The fact that suicide and suicide attempt were more frequent in the criminal groups than non-criminals could be an effect of both alcohol or other substance use but also psychiatric disorders or other negative life circumstances[29].

Somewhat surprisingly, poisoning as the method of completed suicide was more frequent in the two criminal groups than in non-criminals, while hanging is the most common method among

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

men in Sweden; however, to the best of our knowledge, no earlier studies have focused on the choice of suicide method in relation to criminality.

In a study by Titelman et al[30] suicide by hanging or firearm was the most common methods in the Nordic countries. The aggressive methods were more common among men and poisoning among females. It has been argued that suicide attempts by poisoning have mostly non-fatal outcome because of lower dosages after the introduction of blister packaging and often being rescued by accessible emergency care[31]. In this study we found that nearly half of those who had committed suicide had used poisoning as a method followed by hanging. However the criminals were more likely having used poisoning and a possible explanation to our finding is that alcohol and substance use was more common in the criminal groups. Even after analyses of suicides with intent and uncertain intent poisoning was still the most common method in this cohort and especially in the criminal groups.

We found that violent offenders had nearly six times higher crude risk and non-violent offenders more than two-fold higher risk for suicide mortality at the age of 30 years or older. Even after controlling for multiple confounders the hazards remained significant. Alcohol and substance misuse and attempted suicide in the fully adjusted model were confounding on suicide, which imply a strong association between these clinical predictors and suicide risk.

Suicide attempts had been experienced by 1192 (2.4%), which could be considered as rather low frequency when comparing with the completed suicides (n=615). Studies have indicated that suicide attempts are up to 20 times more frequent than completed suicide[1]. We had data on only suicide attempts needing inpatient care, namely serious suicide attempts, which could explains the ratio. We have no knowledge about attempted suicides that not turn up as hospital records. Some suicide attempters do not search help at any care givers[32-33].

In our study, one of five suicide victims had attempted suicide, indicating a strong association between attempted and completed suicide. This was especially evident for violent offenders where

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

one in three had experienced attempted suicide. 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). Additionally, factors as socioeconomic status and school performance are important factors for suicidal behavior and suicides[35-36].

Further, the criminal offenders were more likely to have experiences of psychiatric diagnoses already at the age at 18 compared to no offenders. Alcohol misuse has also in other studies been pointed out as a severe risk factor for suicide and in some studies the second most common diagnostic group[37].Wilcox et al[16]found alcohol misusers having a 10-fold increase risk for suicide in a mixed-age cohort. Likewise, in a longitudinal cohort study by Flensborg-Madsen et al[38] individuals with alcohol use disorders had eight times higher hazards of suicide compared to individuals with no alcohol use. The hazard fell to three after adjustment of psychiatric disorders. In the present study, about half of the violent offenders had reported either risky alcohol or substance use at the time of conscription. Whether alcohol leads to violence or vice versa seems to be unclear[39]. The fact that the suicide rate is somewhat higher in the violent criminals than non-violent criminals, one could assume that alcohol misuse play an important role for both violence and suicide[38].

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 contribute to psychiatric illness[40]. However, studies from Scotland and Wales fond that the suicide rates are also unusually high among non-custody offenders when comparing to the general population[41-42].

One possible explanation to our finding is that alcohol and substance use is more common in the criminal groups including fatal and non-fatal poisonings compared to non-criminals.

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

The yearly incidence rates of suicide mortality have not shown a clear decrease as other cause of deaths in the younger age categories in Sweden, why it is important to identify delinquency at young ages and other related risk factors in order to find preventive strategies for this group[6]. There are evidence that suicide rates are high also in the older ages, often due to loneliness, anxiety disorder and depression[43]. This in turn indicates the importance of early detection and prevention strategies and treatment for substance users and especially those with suicidal tendencies[37].

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

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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

Conclusions

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

Acknowledgements

We want to thank Anders Leifman for the statistical advice. **Competing interests: none.**

Funding: The research for this study was supported by Co-ordination of the Swedish Drug Policy (Dnr 238/2006:18) and by the Swedish Research Council (Project numbers: K2009-61P-21304-04-4; K2009-61X-21305-01-1).

For peer review only

Contributors: MS planned the study, conducted the statistical analyses and wrote the final version of the manuscript. AS contributed to the planning and data analyses. JJ and AR contributed to the planning of the study and preparing of the manuscript. All authors contributed to the final draft of the manuscript.

Ethics approval: .Karolinska Institute Research Ethics Committee (Dnr 2007/174-31, Dnr 2008/1086-31/5).

For peer review only

Reference

1. World Health Organization, World suicide prevention day 2012. http://www. who.int/mediacentre/events/annual/ world suicide prevention day/en/

2. Bertolote JM, Fleischmann A. A global perspective on the magnitude of suicide mortality. In: D Wasserman and C Wasserman (eds.). Oxford Textbook of Suicidology and Suicide Prevention: a global perspective. Oxford: Oxford University Press.2009;91-98.

3. Patton GC, Coffey C, Sawyer SM et al. Global patterns of mortality in young people: a systematic analysis of population health data. Lancet 2009;**374**: 881-892.

4. Karimina A, Law MG, Butler TG et al. Suicide risk among recently released prisoners in New South Wales, Australia. Med J Aust 2007;**18**:387-390.

5. Fazel S, Benning R, Danesh J. Suicides in male prisoners in England and Wales, 1978-2003. Lancet 2005;**366**:1301-2.

6. Webb R, Qin P, Stevens H. National study of suicide in all people with a criminal justice history. Arch Gen Psychiatr 2011;**68**,591-9.

7. Boardman AP, Grimbaldeston AH, Handley C,et. al. The North Staffordshire Suicide Study: a case-control study of suicide in one health district. Psychol Med 1999;**29:**27- 33.

8. Linsley KR, Johnson N, Martin J. Police contact within 3 months of suicide and associated health service contact. Br J Psychiatry 2007;**190**:170-1.

9. Björkenstam E, Björkenstam C, Vinnerljung B et al. Juvenile delinquency, social background-a Swedish national cohort study of 992881 young adults. Int J Epidemiol 2011;**40**:1585-92.

10. Harris EC, Barraclough B. Suicide as an outcome for mental disorders. A meta-analysis. Br J Psychiatry 1997;**170**:205-28

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

11.Tidemalm D, Långström N, Lichtenstein P. et al., Risk of suicide after suicide attempt according to coexisting psychiatric disorder: Swedish cohort study with long term follow-up. BMJ 2008;**337**:a2205doi:10.1136/bmj.a2205.

12. Runesson B, Tidemalm D, Dahlin M et al. Method of attempted suicide as predictor of subsequent successful suicide: national long term cohort study. BMJ 2010;**340**:c3222doi:10.1136/bmj.c3222.

13. Stenbacka M, Moberg T, Romelsjö A et al. Mortality and causes of death among violent offenders and victims - a Swedish population based longitudinal study. BMC public health 2012;**12:**1-10.

14. Darke S, Douflou J, Torok M. Toxicology and circumstances of completed suicide by means other than overdose. J Forensic Sci 2009;**54**:490-4.

15. Darke S, Duflou J, Totok M. Toxicology and characteristics of fatal oxycodone toxicity cases in New South Wales, Australia 1999-2008. J Forensic Sci 2011;**56**:690-3.

16. Wilcox HC, Conner KR, Caine ED. Association of alcohol and drug use disorders and completed suicide: an empirical review of cohort studies. Drug Alc Depend 2004;**7**:11-19.

17. Allebeck P, Allgulander C, Fisher LD. Predictors of completed suicide in a cohort of 50465 young men: role of personality and deviant behaviour. BMJ 1988;**297**:176-178.

18. Andreasson S, Allebeck P, Romelsjo A. Alcohol and mortality among young men. Longitudinal study of Swedish conscripts. Br Med J 1988;**296**:1021-5.

19. Eriksson A, Romelsjö A, Stenbacka M. et al. Early risk factors for criminal offending in schizophrenia: a 35-year longitudinal cohort study. Soc Psychiatr Epidemiol. 2011 **46:**925-32

20. Stenbacka M, Leifman L, Dalal K,et al.. Early Predictors of Injury Mortality among Swedish Conscripts:A 35-Year Follow-up Study. Accid Anal Prev 2011;**43**:228-34.

21. Davstad I, Allebeck P, Leifman A et al. Self-reported drug use and mortality among a nationwide sample of Swedish conscripts – A 35-year follow-up. Drug Alc Depend 2011;

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

118:383-90.

22. Otto U: Male youths. A sociopsychiatric study of a total annual population of Swedish adolescent boys. Acta Psychiatr Scand 1976;Suppl **264**:1-312.

23.Benson G, Holmberg MB: Validity of questionnaire in population studies on drug use. Acta Psychiatr Scand 1985;**70**:9-18.

24. Rydelius P-A. Alcohol-abusing teenage boys. Acta Psychiatr Scand 1983;**68**:368-80.

25. Ståhlberg B. I-provet (intelligence test: the Swedish enlistment battery). Karlstad: Militärpsykologiska Institutet.1971. (In Swedish)

26. David AS, Malmberg L, Brandt L et al. 1997. IQ and risk for schizophrenia: a population-based cohort study. Psychol Med 1997;**27**:1311–23.

27. Kullgren G, Tengström A, Grann M.Suicide among personality-disordered offenders: a follow-up study of 1943 male criminal offenders. Psychiatr Epidemiol 1998;**33**:102-6.

28. Jokinen J, Forslund K, Nordström AL et al. Suicide risk after homicide in Sweden. Arch Suicide Res 2009; **13**:297-301.

29. Jokinen J, Forslund K, Ahnemark E et al. Karolinska Interpersonal Violence Scale predicts suicide in suicide attempters**.** J Clin Psychiatry 2010; **71:**1025-1032

30. Titelman D, Oskarsson H, Wahlbeck K et al. Suicide mortality trends in the Nordic countries 1980 – 2009. Nord J Psychiatry 2013; Early Online:1–10.23293897.

31. Hawton K, Simkin S, Deeks J et al. UK legislation on analgesic packs: Before and after study of long term effect on poisonings. BMJ 2004; **329**:1076.

32. Guilherme B, Jules A, Nock MK et al. Risk factors for twelve-month suicide attempts in the National Comorbidity Survey Replication (NCS-R). Psychol Med 2006;**36**:1747–57.

33. De Leo D, Ester C, Kym S et al. Lifetime risk of suicide ideation and attempts in an Australian community: Prevalence, suicidal process, and help-seeking behaviour. 2005;**86:**215–24.

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

34. Suominen K, Isometsa E, Suokas J et al. Completed suicide after a suicide attempt: a 37-year follow-up study. Am J Psychiatry 2004;**161**:562-563.

35. Jablonska B, Lindblad F, Östberg V et al. A national cohort study of parental socioeconomic status and non-fatal suicidal behaviour-the mediating role of school performance. BMC Public Health 2012, **12**:17.

36. Pritchard C, Cox M, Dawson A. Suicide and 'violent' death in a six-year cohort of male probationers compared with pattern of mortality in the general population: evidence of accumulative socio-psychiatric vulnerability. J R Soc Health 1997;**117**;180- 185

37. Waern M. Alcohol dependence and abuse in elderly suicides. Alcohol and Alcoholism 2003;**38:**249-254.

38. Flensborg-Madsen T, Knop J, Mortensen EL et al. Alcohol use disorders increase the risk of completed suicide — Irrespective of other psychiatric disorders. A longitudinal cohort study. Psychiatry Research 2009;**167**;123–130.

39. Lipsey MW, Wilson DB, Cohen MA, Derzon JH: Is there a causal relationship between alcohol use and violence? A synthesis of evidence. Recent Dev Alcohol 1997;**13**:245-82.

40. Sattar G, Killias M. The death of offenders in Switzerland. Eur J Crim 2005; **2**:317-40.

41. Sattar G. Rates and causes of death among prisoners and offenders under community supervision. Home Office Research Study. London Home Office. 2001;231.

42. Sattar G. The death of offenders in England and Wales. Crisis 2003;**24**:1:17- 23.

43. Waern M. Risk factors for suicide in the elderly: What do we know? What do we need to find out? Suicidologi 2011;**16**:2:3-8.

44. King E, Barraclough B. Violent death and mental illness: A study of a single catchment area over eight years. Br J Psychiatry 1990;**156**;714-20.

45.Carlborg A,Winnerbäck K, Jönsson EG. et al. Suicide in schizophrenia. Expert Review of Neurotherapeutics 2010;**10**,1153–1164.

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

46. Stattin H, Romelsjö R, Stenbacka M. Personal resources as modifiers of the risk for future criminality: an analysis of protective factors in relation to 18-year-old boys. Br J Criminol 1997;**37:**198–223

For peer review only

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	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	

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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

For peer review only

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	

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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.

For peer review only

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 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.

.

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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

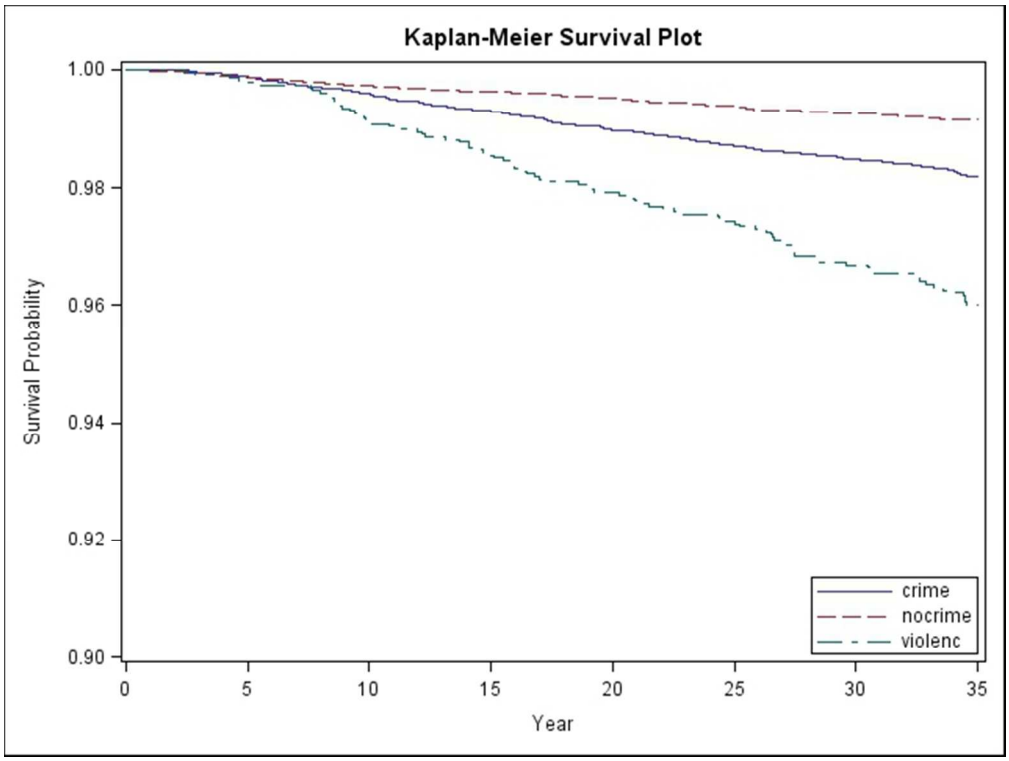
For peer review only

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	9-11, 22-26
		(*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	
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.

For peer review only



162x121mm (100 x 100 DPI)

For peer review only

BMJ open

Criminality and Suicide – A longitudinal Swedish Cohort Study

Journal:	*BMJ Open*
Manuscript ID:	bmjopen-2013-003497.R1
Article Type:	Research
Date Submitted by the Author:	13-Sep-2013
Complete List of Authors:	Stenbacka, Marlene; Karolinska Institute, Public Health Sidorchuk, Anna; Karolinska Institute, Public Health Sciences Romelsjö, Anders; Karolinska Institute, Public Health Sciences Jokinen, Jussi; Karolinska Institute, Clinical Neuroscience
Primary Subject Heading:	Epidemiology
Secondary Subject Heading:	Public health, Mental health, Epidemiology, Addiction
Keywords:	EPIDEMIOLOGY, Substance misuse < PSYCHIATRY, Suicide & self-harm < PSYCHIATRY, PUBLIC HEALTH

SCHOLARONE™
Manuscripts

For peer review only

Criminality and Suicide–A longitudinal Swedish Cohort Study

Stenbacka M.,1,2) Sidorchuk A.,2) Romelsjö A.,2) Jokinen J.,3)

1). Addiction Center Stockholm, S:t Eriks Hospital Polhemsgatan 60, 112 82 Stockholm, Sweden.

2). Department of Public Health Sciences, Karolinska Institute, Widerströmska Building, 171 76 Stockholm, Sweden.

3). Department of Clinical Neuroscience, Karolinska Institute, Karolinska University Hospital Solna, 171 76 Stockholm, Sweden.

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

Word count: 3698

For peer review only

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

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

- 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.

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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

In this representative, nationwide, general population study we followed 49,398 Swedish conscripts during 35 years, in order to examine whether both violent and non-violent offending were related to elevated risk of suicide. We also investigated if the risk is higher among those with repeated offences and how substance abuse and suicide attempt history modified the relationship. Moreover, we studied the choice of suicide methods for the violent and non-violent criminal groups.

This study aimed to address four main research questions:

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

(2) Does suicide risk increase with repeated offences?

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

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

MATERIAL AND METHODS

Participants

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

Measures

Measurement of potential confounders

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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

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

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

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

Intellectual ability (IQ) was based on four main intellectual and cognitive tests, measuring verbal, logical-inductive, spatial, and technical and mechanical ability. The results of the tests were aggregated in a 5-point summary score for overall intelligence, as described in detail by

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Ståhlberg[25] and David et al.[26] These scale of intelligence capacity was scored 1=very bad; 2=bad; 3=moderate; 4=good; 5=very good and expressed as intelligence (1–3 vs. 4–5). Details of this procedure and the validity of the assessments have been described by Otto.[22]

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

Measures of alcohol and drug misuse and suicide attempt

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

Suicide

Cause of Death Register provides mortality data and covers more than 99% of all deaths occurring in Sweden and is based on information from death certificates. Suicide was classified

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

according to ICD-8 and ICD-9: E950-E959 and ICD-10: X60-X84 or as death with undetermined intent ICD-8 and ICD-9: E980-E989 and ICD-10: Y10-Y34. The same ICD-codes as for the hospital register.

Measurement of crime

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

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

Statistical analyses

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

We had no exact information whether a person had emigrated from Sweden or not during the follow-up period, therefore we could not censor for emigration in the calculation of person time. In order to investigate the association between the number of criminal offences and mortality, we categorized subjects according to committed numbers of offences (0, 1, 2 and more) in relation to the time to suicide by using Cox proportional regression analysis. We adjusted for potential risk

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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

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

We found that poisoning as method of completed suicide was most prevalent in violent and non-violent criminals, while hanging was the most prevalent method among non-criminals. That was also the case for men in the whole of Sweden.[31] In a Danish national register study of 9708 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

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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

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

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

Suicide attempts had been experienced by 1192 men (2.4%), which could be considered as rather low frequency when comparing with the completed suicides (n=615). An American national study (National Survey on Drug Use and Health), based on interviews and web-questionnaires from 92,264 respondents in year 2008 and 2009, found one suicide case for every 25 attempted suicides.[39] We had data on only suicide attempts needing inpatient care, namely serious suicide attempts, which could explain the ratio. We did not have data on attempted suicides that not turn up as hospital records. Some suicide attempters do not search help at any care givers.[40-41]. In our study, one out of five suicide victims had attempted suicide, confirming a strong association between attempted and completed suicide. This was especially evident for violent offenders where one in three had experienced attempted suicide. Suicide attempt has been considered as one of the

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

strongest predictors of suicide and the risk seem to be elevated up to older ages and during long time periods.[42] Alcohol misuse has also in other studies been pointed out as a severe risk factor for suicide and in some studies the second most common diagnostic group.[35,43].Wilcox et al.[16]found alcohol misusers having a 10-fold increase risk for suicide in a mixed-age cohort. Likewise, in a longitudinal cohort study by Flensborg-Madsen et al.,[44] individuals with alcohol use disorders had eight times higher hazard ratios of suicide compared to individuals with no alcohol use. The hazard ratio fell to three after adjustment of psychiatric disorders. These findings indicate the importance of early detection and prevention strategies and treatment for substance users and especially those with suicidal tendencies in all ages.[36] In the present study, about half of the violent offenders had reported either risky alcohol or substance use at the time of conscription and nearly one third had been treated at hospital for an alcohol related diagnosis. The relationship between alcohol use and violence seems to be complex.[45] The fact that the suicide rate is somewhat higher in the violent criminals than non-violent criminals, one could assume that alcohol misuse play an important role for both violence and suicide [43].

We found that one third of the violent offenders were already diagnosed at conscription with a psychiatric diagnosis. Psychiatric disorders are strongly related to suicide risk, whereas the association between mental illness and violent crime is not as evident. King and Barraclough[45] 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. Persons with severe psychiatric disorders like affective disorder and schizophrenia have highly elevated lifetime suicide risk.[46-47]

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 disorders. The two questionnaires used at conscription

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

were non-anonymous, which could have contributed 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. That was especially evident for those subjects who had committed violent offences whereas the response rate for the confounders included in the study varied from 0.26 to 9.45%. The corresponding measures for other criminality and non-criminals were: 0.20 to 6.37% and 0.13 to 4.19%. The violent offenders had probably more severe risk factors than the non-violent and non-criminal groups which could have resulting in underestimating of the hazard ratios of suicide. One could assume that these subjects also had higher rates of substance use and other maladjusted behaviour measured at conscription which in turn could have affected the outcome.[48] However, we have no reason to believe that the risk for the outcome, suicide, has been considerable affected due the internal missing data.

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

Conclusions

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

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

for suicide in both violent and non-violent criminals, especially those with earlier suicide attempt and comorbid alcohol and substance misuse.

Acknowledgements We want to thank statistician Anders Leifman for the valuable statistical advice.

Competing interests: none.

Funding: The research for this study was supported by Co-ordination of the Swedish Drug Policy (Dnr 238/2006:18), by the Swedish Research Council (Project numbers: K2009-61P-21304-04-4; K2009-61X-21305-01-1) and through the regional agreement on medical training and clinical research (ALF) between Stockholm County Council and Karolinska Institutet, Stockholm Centre for Psychiatric Research and Education.

Contributors: MS planned the study, conducted the statistical analyses and wrote the final version of the manuscript. AS contributed to the planning and data analyses. JJ and AR contributed to the planning of the study and preparing of the manuscript. All authors contributed to the final draft of the manuscript.

Ethics approval: Karolinska Institute Research Ethics Committee (Dnr 2007/174-31, Dnr 2008/1086-31/5).

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Reference

1. World Health Organization, World suicide prevention day 2012. http://www. who.int/mediacentre/events/annual/ world suicide prevention day/en/

1. Bertolote JM, Fleischmann A. A global perspective on the magnitude of suicide mortality. In: D Wasserman and C Wasserman (eds.). Oxford Textbook of Suicidology and Suicide Prevention: a global perspective. Oxford: Oxford University Press.2009;91-98.

2. Patton GC, Coffey C, Sawyer SM et al. Global patterns of mortality in young people: a systematic analysis of population health data. Lancet 2009;**374**: 881-892.

3. Karimina A, Law MG, Butler TG et al. Suicide risk among recently released prisoners in New South Wales, Australia. Med J Aust 2007;**18**:387-390.

4. Fazel S, Benning R, Danesh J. Suicides in male prisoners in England and Wales, 1978-2003. Lancet 2005;**366**:1301-2.

5. Webb R, Qin P, Stevens H. National study of suicide in all people with a criminal justice history. Arch Gen Psychiatr 2011;**68**,591-9.

6. Hayes LM. National study of jail suicides: seven year later. Psychiatr Q 1989;**60**:7-29.

7. Boardman AP, Grimbaldeston AH, Handley C. et. al. The North Staffordshire Suicide Study: a case-control study of suicide in one health district. Psychol Med 1999;**29:**27- 33.

8. Linsley KR, Johnson N, Martin J. Police contact within 3 months of suicide and associated health service contact. Br J Psychiatry 2007;**190**:170-1.

9. Björkenstam E, Björkenstam C, Vinnerljung B et al. Juvenile delinquency, social background-a Swedish national cohort study of 992881 young adults. Int J Epidemiol 2011;**40**:1585-92.

10. Harris EC, Barraclough B. Suicide as an outcome for mental disorders. A meta-analysis. Br J Psychiatry 1997;**170**:205-28.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

11. Tidemalm D, Långström N, Lichtenstein P. et al., Risk of suicide after suicide attempt according to coexisting psychiatric disorder: Swedish cohort study with long term follow-up. BMJ 2008;**337**:a2205doi:10.1136/bmj.a2205.

12. Runeson B, Tidemalm D, Dahlin M et al. Method of attempted suicide as predictor of subsequent successful suicide: national long term cohort study. BMJ 2010; **340**:c3222doi:10.1136/bmj.c3222.

13. Stenbacka M, Moberg T, Romelsjö A et al. Mortality and causes of death among violent offenders and victims - a Swedish population based longitudinal study. BMC public health 2012;**12:**1-10.

14. Darke S, Douflou J, Torok M. Toxicology and circumstances of completed suicide by means other than overdose. J Forensic Sci 2009;**54**:490-4.

15. Darke S, Duflou J, Totok M. Toxicology and characteristics of fatal oxycodone toxicity cases in New South Wales, Australia 1999-2008. J Forensic Sci 2011;**56**:690-3.

16. Wilcox HC, Conner KR, Caine ED. Association of alcohol and drug use disorders and completed suicide: an empirical review of cohort studies. Drug Alc Depend 2004;**7**:11-19.

17. Allebeck P, Allgulander C, Fisher LD. Predictors of completed suicide in a cohort of 50465 young men: role of personality and deviant behaviour. BMJ 1988;**297**:176-178.

18. Andreasson S, Allebeck P, Romelsjo A. Alcohol and mortality among young men. Longitudinal study of Swedish conscripts. Br Med J 1988;**296**:1021-5.

19. Eriksson A, Romelsjö A, Stenbacka M. et al. Early risk factors for criminal offending in schizophrenia: a 35-year longitudinal cohort study. Soc Psychiatr Epidemiol. 2011 **46:**925-32.

20. Stenbacka M, Leifman L, Dalal K,et al.. Early Predictors of Injury Mortality among Swedish Conscripts:A 35-Year Follow-up Study. Accid Anal Prev 2011;**43**:228-34.

21. Davstad I, Allebeck P, Leifman A et al. Self-reported drug use and mortality among a nationwide sample of Swedish conscripts – A 35-year follow-up. Drug Alc Depend 2011;

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

118:383-90.

22. Otto U: Male youths. A sociopsychiatric study of a total annual population of Swedish adolescent boys. Acta Psychiatr Scand 1976;Suppl **264**:1-312.

23. Benson G, Holmberg MB: Validity of questionnaire in population studies on drug use. Acta Psychiatr Scand 1985;**70**:9-18.

24. Rydelius P-A. Alcohol-abusing teenage boys. Acta Psychiatr Scand 1983;**68**:368-80.

25. Ståhlberg B. I-provet (intelligence test: the Swedish enlistment battery). Karlstad. Militärpsykologiska Institutet.1971. (In Swedish)

26. David AS, Malmberg L, Brandt L et al. 1997. IQ and risk for schizophrenia: a population-based cohort study. Psychol Med 1997;**27**:1311–23.

27. Kullgren G, Tengström A, Grann M. Suicide among personality-disordered offenders: a follow-up study of 1943 male criminal offenders. Psychiatr Epidemiol 1998;**33**:102-6.

28. Jokinen J, Forslund K, Nordström AL et al. Suicide risk after homicide in Sweden. Arch Suicide Res 2009; **13**:297-301.

29. Jokinen J, Forslund K, Ahnemark E et al. Karolinska Interpersonal Violence Scale predicts suicide in suicide attempters**.** J Clin Psychiatry 2010; **71:**1025-1032.

30. Waern M. Risk factors for suicide in the elderly: What do we know? What do we need to find out? Suicidologi 2011;**16**:2:3-8.

31. National Board on Health and Welfare, The Cause of Death Register, 2012.

32. Webb RT, Qin P, Stevens H, Shaw J, Appleby L, Mortensen PB. National study of suicide method in violent criminal offenders. J Affect Disord 2013; [http://dx.doi.org/ 10.1016/j.jad.2013.04.001].

33. Titelman D, Oskarsson H, Wahlbeck K et al. Suicide mortality trends in the Nordic countries 1980–2009. Nord J Psychiatry 2013;1–10.23293897.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

34. Sattar G. Rates and causes of death among prisoners and offenders under community supervision. Home Office Research Study. London Home Office. 2001;231.

35. Waern M. Alcohol dependence and abuse in elderly suicides. Alcohol and Alcoholism 2003;38:249-254.

36. Whiteford HA, Degenhardt L, Rehm J et al. Global burden of disease attributable to mental and substance use disorders: findings from the Global Burden of Disease Study 2010. Lancet 2013;28. doi:pii: S0140-6736(13)61611-6. 10.1016/S0140-6736(13)61611-6

37. Hawton K, Simkin S, Deeks J et al. UK legislation on analgesic packs: Before and after study of long term effect on poisonings. BMJ 2004; **329**:1076.

38. Hawton K, Bergen H, Simkin S et al. Long term effect of reduced pack sizes of paracetamol on poisoning deaths and liver transplant activity in England and Wales: interrupted time series analyses. BMJ 2013: 346, f403. doi:10.1136/bmj.f403.

39.Crosby AE, Han B, Ortega LAG et al. Suicidal thoughts and behaviors among adults aged ≥18 years-United States, 2008-2009. MMWR Surveillance Summaries 2011;60(no. SS-13).

40. Guilherme B, Jules A, Nock MK et al. Risk factors for twelve-month suicide attempts in the National Comorbidity Survey Replication (NCS-R). Psychol Med 2006;**36**:1747–57.

41. De Leo D, Ester C, Kym S et al. Lifetime risk of suicide ideation and attempts in an Australian community: Prevalence, suicidal process, and help-seeking behaviour. 2005;**86:**215–24.

42. Suominen K, Isometsa E, Suokas J et al. Completed suicide after a suicide attempt: a 37-year follow-up study. Am J Psychiatry 2004;**161**:562-563.

43. Flensborg-Madsen T, Knop J, Mortensen EL et al. Alcohol use disorders increase the risk of completed suicide—Irrespective of other psychiatric disorders. A longitudinal cohort study. Psychiatry Research 2009;**167**;123–130.

44. Lipsey MW, Wilson DB, Cohen MA, Derzon JH: Is there a causal relationship between alcohol use and violence? A synthesis of evidence. Recent Dev Alcohol 1997;**13**:245-82.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

45. King E, Barraclough B. Violent death and mental illness: A study of a single catchment area over eight years. Br J Psychiatry 1990;**156**;714-20.

46.Carlborg A,Winnerbäck K, Jönson EG. et al. Suicide in schizophrenia. Expert Review of Neurotherapeutics 2010;**10**,1153–1164.

47. Nordentoft M, Mortensen PB, Pedersen CB. Absolute risk of suicide after first hospital contact in mental disorder. Arch Gen Psychiatry. 2011;**68**(10):1058-64.

48. Stattin H, Romelsjö R, Stenbacka M. Personal resources as modifiers of the risk for future criminality: an analysis of protective factors in relation to 18-year-old boys. Br J Criminol 1997;**37:**198–223.

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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	

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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	

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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

For Peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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 Non-violent crime Violent crime	1.0 2.94, 2.26-3.81 6.92, 4.91-9.76
Hanging/suffocation (n=149): E953, E983, X70, Y20	No crime Non-violent crime Violent crime	1.0 1.28, 0.90-1.83 2.54, 1.47-4.40
Firearm (n=69): E955,E985, X722-X74, Y422-Y424	No crime Non-violent crime Violent crime	1.0 1.39, 0.83-2.34 3.08, 1.44-6.60
Drowning (n=41): E954, E984, X71,Y21	No crime Non-violent crime Violent crime	1.0 1.62, 0.82-3.20 5.17, 2.19-12.24
Jump from heights (n=27): E957, E987, X80, Y30	No crime Non-violent crime Violent crime	1.0 3.23,1.43-7.26 4.41, 1.21-16.00
Moving train (n=22): E9580, E9880, X81, Y31	No crime Non-violent crime Violent crime	1.0 2.07, 0.84- 5.10 4.40, 1.21- 15.98
Cutting (n=16): E956, E986,X79,Y28	No crime Non-violent crime Violent crime	1.0 4.61, 1.58-13.50 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 Non-violent crime Violent crime	1.0 2.32, 0.67-8.01 8.99, 2.15-37.63

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

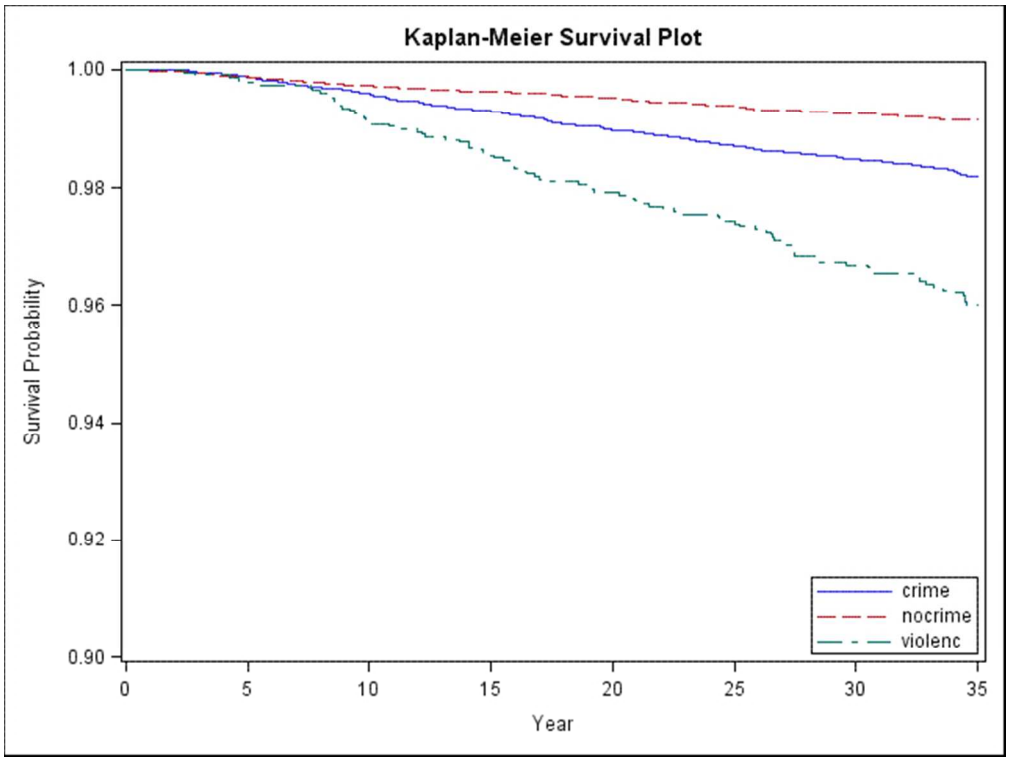
authorities, emotional control, intellectual capacity, psychiatric diagnosis at conscription, sniffing of solvents, risky alcohol misuse and substance misuse.

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

.

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml



225x169mm (72 x 72 DPI)

iew 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

For peer review only

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	9-11, 22-26
		(*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	
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.

For peer review only

Criminality and Suicide–A longitudinal Swedish Cohort Study

Stenbacka M.,1,2) Sidorchuk A.,2) Romelsjö A.,2) Jokinen J.,3)

1). Addiction Center Stockholm, S:t Eriks Hospital Polhemsgatan 60, 112 82 Stockholm, Sweden.

2). Department of Public Health Sciences, Karolinska Institute, Widerströmska Building, 171 76 Stockholm, Sweden.

3). Department of Clinical Neuroscience, Karolinska Institute, Karolinska University Hospital Solna, 171 76 Stockholm, Sweden.

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

Word count: 3698

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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

Formatted: Highlight

Formatted: Highlight

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

- 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.

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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

For peer review only

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

In this representative, nationwide, general population study we followed 49,398 Swedish conscripts during 35 years, in order to examine whether both violent and non-violent offending were related to elevated risk of suicide. We also investigated if the risk is higher among those with repeated offences and how substance abuse and suicide attempt history modified the relationship. Moreover, we studied the choice of suicide methods for the violent and non-violent criminal groups.

This study aimed to address four main research questions:

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

(2) Does suicide risk increase with repeated offences?

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

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

MATERIAL AND METHODS

Participants

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

Measures

Measurement of potential confounders

Formatted: Highlight

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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

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

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

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

Intellectual ability (IQ) was based on four main intellectual and cognitive tests, measuring verbal, logical-inductive, spatial, and technical and mechanical ability. The results of the tests were aggregated in a 5-point summary score for overall intelligence, as described in detail by

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Ståhlberg[25] and David et al.[26] These scale of intelligence capacity was scored 1=very bad; 2=bad; 3=moderate; 4=good; 5=very good and expressed as intelligence (1–3 vs. 4–5). Details of this procedure and the validity of the assessments have been described by Otto.[22]

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

Measures of alcohol and drug misuse and suicide attempt

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

Suicide

Cause of Death Register provides mortality data and covers more than 99% of all deaths occurring in Sweden and is based on information from death certificates. Suicide was classified

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

according to ICD-8 and ICD-9: E950-E959 and ICD-10: X60-X84 or as death with undetermined intent ICD-8 and ICD-9: E980-E989 and ICD-10: Y10-Y34. The same ICD-codes as for the hospital register.

Measurement of crime

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

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

Formatted: Highlight

Statistical analyses

Formatted: Highlight

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

We had no exact information whether a person had emigrated from Sweden or not during the follow-up period, therefore we could not censor for emigration in the calculation of person time. In order to investigate the association between the number of criminal offences and mortality, we categorized subjects according to committed numbers of offences (0, 1, 2 and more) in relation to the time to suicide by using Cox proportional regression analysis. We adjusted for potential risk

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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

Formatted: Highlight

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.

Formatted: Highlight

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

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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

Formatted: Highlight

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

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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

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

We found that poisoning as method of completed suicide was most prevalent in violent and non-violent criminals, while hanging was the most prevalent method among non-criminals. That was also the case for men in the whole of Sweden.[31] In a Danish national register study of 9708 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.

Formatted: Highlight

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

Formatted: Highlight

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

studies on the association between violent and non-violent criminality and suicide have been conducted in a cohort representing the general population and with a long follow-up period.

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

Formatted: Highlight

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

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

Suicide attempts had been experienced by 1192 men (2.4%), which could be considered as rather low frequency when comparing with the completed suicides (n=615). An American national study (National Survey on Drug Use and Health), based on interviews and web-questionnaires from 92,264 respondents in year 2008 and 2009, found one suicide case for every 25 attempted suicides.[39] We had data on only suicide attempts needing inpatient care, namely serious suicide attempts, which could explain the ratio. We did not have data on attempted suicides that not turn up as hospital records. Some suicide attempters do not search help at any care givers.[40-41]. In our study, one out of five suicide victims had attempted suicide, confirming a strong association between attempted and completed suicide. This was especially evident for violent offenders where one in three had experienced attempted suicide. Suicide attempt has been considered as one of the

For peer review only

strongest predictors of suicide and the risk seem to be elevated up to older ages and during long time periods.[42] Alcohol misuse has also in other studies been pointed out as a severe risk factor for suicide and in some studies the second most common diagnostic group.[35,43].Wilcox et al.[16]found alcohol misusers having a 10-fold increase risk for suicide in a mixed-age cohort. Likewise, in a longitudinal cohort study by Flensborg-Madsen et al.,[44] individuals with alcohol use disorders had eight times higher hazard ratios of suicide compared to individuals with no alcohol use. The hazard ratio fell to three after adjustment of psychiatric disorders. These findings indicate the importance of early detection and prevention strategies and treatment for substance users and especially those with suicidal tendencies in all ages.[36] In the present study, about half of the violent offenders had reported either risky alcohol or substance use at the time of conscription and nearly one third had been treated at hospital for an alcohol related diagnosis. The relationship between alcohol use and violence seems to be complex.[45] The fact that the suicide rate is somewhat higher in the violent criminals than non-violent criminals, one could assume that alcohol misuse play an important role for both violence and suicide [43].

We found that one third of the violent offenders were already diagnosed at conscription with a psychiatric diagnosis. Psychiatric disorders are strongly related to suicide risk, whereas the association between mental illness and violent crime is not as evident. King and Barraclough[45] 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. Persons with severe psychiatric disorders like affective disorder and schizophrenia have highly elevated lifetime suicide risk.[46-47]

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 disorders. The two questionnaires used at conscription

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

were non-anonymous, which could have contributed 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. That was especially evident for those subjects who had committed violent offences whereas the response rate for the confounders included in the study varied from 0.26 to 9.45%. The corresponding measures for other criminality and non-criminals were: 0.20 to 6.37% and 0.13 to 4.19%. The violent offenders had probably more severe risk factors than the non-violent and non-criminal groups which could have resulting in underestimating of the hazard ratios of suicide. One could assume that these subjects also had higher rates of substance use and other maladjusted behaviour measured at conscription which in turn could have affected the outcome.[48] However, we have no reason to believe that the risk for the outcome, suicide, has been considerable affected due the internal missing data.

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

Conclusions

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

For peer review only

for suicide in both violent and non-violent criminals, especially those with earlier suicide attempt and comorbid alcohol and substance misuse.

Acknowledgements We want to thank statistician Anders Leifman for the valuable statistical advice.

Competing interests: none.

Funding: The research for this study was supported by Co-ordination of the Swedish Drug Policy (Dnr 238/2006:18), by the Swedish Research Council (Project numbers: K2009-61P-21304-04-4; K2009-61X-21305-01-1) and through the regional agreement on medical training and clinical research (ALF) between Stockholm County Council and Karolinska Institutet, Stockholm Centre for Psychiatric Research and Education.

Contributors: MS planned the study, conducted the statistical analyses and wrote the final version of the manuscript. AS contributed to the planning and data analyses. JJ and AR contributed to the planning of the study and preparing of the manuscript. All authors contributed to the final draft of the manuscript.

Ethics approval: Karolinska Institute Research Ethics Committee (Dnr 2007/174-31, Dnr 2008/1086-31/5).

Formatted: Highlight

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Reference

1. World Health Organization, World suicide prevention day 2012. http://www. who.int/mediacentre/events/annual/ world suicide prevention day/en/

1. Bertolote JM, Fleischmann A. A global perspective on the magnitude of suicide mortality. In: D Wasserman and C Wasserman (eds.). Oxford Textbook of Suicidology and Suicide Prevention: a global perspective. Oxford: Oxford University Press.2009;91-98.

2. Patton GC, Coffey C, Sawyer SM et al. Global patterns of mortality in young people: a systematic analysis of population health data. Lancet 2009;**374**: 881-892.

3. Karimina A, Law MG, Butler TG et al. Suicide risk among recently released prisoners in New South Wales, Australia. Med J Aust 2007;**18**:387-390.

4. Fazel S, Benning R, Danesh J. Suicides in male prisoners in England and Wales, 1978-2003. Lancet 2005;**366**:1301-2.

5. Webb R, Qin P, Stevens H. National study of suicide in all people with a criminal justice history. Arch Gen Psychiatr 2011;**68**,591-9.

6. Hayes LM. National study of jail suicides: seven year later. Psychiatr Q 1989;**60**:7-29.

7. Boardman AP, Grimbaldeston AH, Handley C. et. al. The North Staffordshire Suicide Study: a case-control study of suicide in one health district. Psychol Med 1999;**29:**27- 33.

8. Linsley KR, Johnson N, Martin J. Police contact within 3 months of suicide and associated health service contact. Br J Psychiatry 2007;**190**:170-1.

9. Björkenstam E, Björkenstam C, Vinnerljung B et al. Juvenile delinquency, social background-a Swedish national cohort study of 992881 young adults. Int J Epidemiol 2011;**40**:1585-92.

10. Harris EC, Barraclough B. Suicide as an outcome for mental disorders. A meta-analysis. Br J Psychiatry 1997;**170**:205-28.

For peer review only

11. Tidemalm D, Långström N, Lichtenstein P. et al., Risk of suicide after suicide attempt according to coexisting psychiatric disorder: Swedish cohort study with long term follow-up. BMJ 2008;**337**:a2205doi:10.1136/bmj.a2205.

12. Runeson B, Tidemalm D, Dahlin M et al. Method of attempted suicide as predictor of subsequent successful suicide: national long term cohort study. BMJ 2010; **340**:c3222doi:10.1136/bmj.c3222.

13. Stenbacka M, Moberg T, Romelsjö A et al. Mortality and causes of death among violent offenders and victims - a Swedish population based longitudinal study. BMC public health 2012;**12:**1-10.

14. Darke S, Douflou J, Torok M. Toxicology and circumstances of completed suicide by means other than overdose. J Forensic Sci 2009;**54**:490-4.

15. Darke S, Duflou J, Totok M. Toxicology and characteristics of fatal oxycodone toxicity cases in New South Wales, Australia 1999-2008. J Forensic Sci 2011;**56**:690-3.

16. Wilcox HC, Conner KR, Caine ED. Association of alcohol and drug use disorders and completed suicide: an empirical review of cohort studies. Drug Alc Depend 2004;**7**:11-19.

17. Allebeck P, Allgulander C, Fisher LD. Predictors of completed suicide in a cohort of 50465 young men: role of personality and deviant behaviour. BMJ 1988;**297**:176-178.

18. Andreasson S, Allebeck P, Romelsjo A. Alcohol and mortality among young men. Longitudinal study of Swedish conscripts. Br Med J 1988;**296**:1021-5.

19. Eriksson A, Romelsjö A, Stenbacka M. et al. Early risk factors for criminal offending in schizophrenia: a 35-year longitudinal cohort study. Soc Psychiatr Epidemiol. 2011 **46:**925-32.

20. Stenbacka M, Leifman L, Dalal K,et al.. Early Predictors of Injury Mortality among Swedish Conscripts:A 35-Year Follow-up Study. Accid Anal Prev 2011;**43**:228-34.

21. Davstad I, Allebeck P, Leifman A et al. Self-reported drug use and mortality among a nationwide sample of Swedish conscripts – A 35-year follow-up. Drug Alc Depend 2011;

Formatted: Highlight

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

118:383-90.

22. Otto U: Male youths. A sociopsychiatric study of a total annual population of Swedish adolescent boys. Acta Psychiatr Scand 1976;Suppl **264**:1-312.

23. Benson G, Holmberg MB: Validity of questionnaire in population studies on drug use. Acta Psychiatr Scand 1985;**70**:9-18.

24. Rydelius P-A. Alcohol-abusing teenage boys. Acta Psychiatr Scand 1983;**68**:368-80.

25. Ståhlberg B. I-provet (intelligence test: the Swedish enlistment battery). Karlstad. Militärpsykologiska Institutet.1971. (In Swedish)

26. David AS, Malmberg L, Brandt L et al. 1997. IQ and risk for schizophrenia: a population-based cohort study. Psychol Med 1997;**27**:1311–23.

27. Kullgren G, Tengström A, Grann M. Suicide among personality-disordered offenders: a follow-up study of 1943 male criminal offenders. Psychiatr Epidemiol 1998;**33**:102-6.

28. Jokinen J, Forslund K, Nordström AL et al. Suicide risk after homicide in Sweden. Arch Suicide Res 2009; **13**:297-301.

29. Jokinen J, Forslund K, Ahnemark E et al. Karolinska Interpersonal Violence Scale predicts suicide in suicide attempters**.** J Clin Psychiatry 2010; **71:**1025-1032.

30. Waern M. Risk factors for suicide in the elderly: What do we know? What do we need to find out? Suicidologi 2011;**16**:2:3-8.

31. National Board on Health and Welfare, The Cause of Death Register, 2012.

32. Webb RT, Qin P, Stevens H, Shaw J, Appleby L, Mortensen PB. National study of suicide method in violent criminal offenders. J Affect Disord 2013; [http://dx.doi.org/ 10.1016/j.jad.2013.04.001].

33. Titelman D, Oskarsson H, Wahlbeck K et al. Suicide mortality trends in the Nordic countries 1980–2009. Nord J Psychiatry 2013;1–10.23293897.

Formatted: Highlight

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

34. Sattar G. Rates and causes of death among prisoners and offenders under community supervision. Home Office Research Study. London Home Office. 2001;231.

35. Waern M. Alcohol dependence and abuse in elderly suicides. Alcohol and Alcoholism 2003;38:249-254.

36. Whiteford HA, Degenhardt L, Rehm J et al. Global burden of disease attributable to mental and substance use disorders: findings from the Global Burden of Disease Study 2010. Lancet 2013;28. doi:pii: S0140-6736(13)61611-6. 10.1016/S0140-6736(13)61611-6

37. Hawton K, Simkin S, Deeks J et al. UK legislation on analgesic packs: Before and after study of long term effect on poisonings. BMJ 2004; **329**:1076.

38. Hawton K, Bergen H, Simkin S et al. Long term effect of reduced pack sizes of paracetamol on poisoning deaths and liver transplant activity in England and Wales: interrupted time series analyses. BMJ 2013: 346, f403. doi:10.1136/bmj.f403.

39.Crosby AE, Han B, Ortega LAG et al. Suicidal thoughts and behaviors among adults aged ≥18 years-United States, 2008-2009. MMWR Surveillance Summaries 2011;60(no. SS-13).

40. Guilherme B, Jules A, Nock MK et al. Risk factors for twelve-month suicide attempts in the National Comorbidity Survey Replication (NCS-R). Psychol Med 2006;**36**:1747–57.

41. De Leo D, Ester C, Kym S et al. Lifetime risk of suicide ideation and attempts in an Australian community: Prevalence, suicidal process, and help-seeking behaviour. 2005;**86:**215–24.

42. Suominen K, Isometsa E, Suokas J et al. Completed suicide after a suicide attempt: a 37-year follow-up study. Am J Psychiatry 2004;**161**:562-563.

43. Flensborg-Madsen T, Knop J, Mortensen EL et al. Alcohol use disorders increase the risk of completed suicide—Irrespective of other psychiatric disorders. A longitudinal cohort study. Psychiatry Research 2009;**167**;123–130.

44. Lipsey MW, Wilson DB, Cohen MA, Derzon JH: Is there a causal relationship between alcohol use and violence? A synthesis of evidence. Recent Dev Alcohol 1997;**13**:245-82.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

45. King E, Barraclough B. Violent death and mental illness: A study of a single catchment area over eight years. Br J Psychiatry 1990;**156**;714-20.

46.Carlborg A,Winnerbäck K, Jönson EG. et al. Suicide in schizophrenia. Expert Review of Neurotherapeutics 2010;**10**,1153–1164.

47. Nordentoft M, Mortensen PB, Pedersen CB. Absolute risk of suicide after first hospital contact in mental disorder. Arch Gen Psychiatry. 2011;**68**(10):1058-64.

48. Stattin H, Romelsjö R, Stenbacka M. Personal resources as modifiers of the risk for future criminality: an analysis of protective factors in relation to 18-year-old boys. Br J Criminol 1997;**37:**198–223.

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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	

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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	

For peer review only

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

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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

Formatted: Highlight

For peer review only

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.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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.

.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

BMJ open

Criminality and Suicide – A longitudinal Swedish Cohort Study

Journal:	*BMJ Open*
Manuscript ID:	bmjopen-2013-003497.R2
Article Type:	Research
Date Submitted by the Author:	19-Nov-2013
Complete List of Authors:	Stenbacka, Marlene; Karolinska Institute, Public Health Sidorchuk, Anna; Karolinska Institute, Public Health Sciences Romelsjö, Anders; Karolinska Institute, Public Health Sciences Jokinen, Jussi; Karolinska Institute, Clinical Neuroscience
Primary Subject Heading:	Epidemiology
Secondary Subject Heading:	Public health, Mental health, Epidemiology, Addiction
Keywords:	EPIDEMIOLOGY, Substance misuse < PSYCHIATRY, Suicide & self-harm < PSYCHIATRY, PUBLIC HEALTH

SCHOLARONE™
Manuscripts

For peer review only

Criminality and Suicide–A longitudinal Swedish Cohort Study

Stenbacka M.,1,2) Sidorchuk A.,2) Romelsjö A.,2) Jokinen J.,3)

1). Addiction Center Stockholm, S:t Eriks Hospital Polhemsgatan 60, 112 82 Stockholm, Sweden.

2). Department of Public Health Sciences, Karolinska Institute, Widerströmska Building, 171 76 Stockholm, Sweden.

3). Department of Clinical Neuroscience, Karolinska Institute, Karolinska University Hospital Solna, 171 76 Stockholm, Sweden.

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

Word count: 3640

For peer review only

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.

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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]

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

In a Swedish national register based study, it was found that patients who had attempted suicide by hanging evinced highest risk for 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 more prevalent in substance users than in the general population. For instance, Darke et al.[15] found that about one third of the substance misusers had experiences of suicide attempts. Suicide among opioid misusers has been estimated to be 14 times higher than the general population.[10,16] Further, one fifth or more of the suicide cases had substances presented in the blood in one study.[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 significantly associated with high rate of suicide.[17] Likewise, a longitudinal study of offenders and victims of violence and cause specific mortality showed that the hazard ratio for suicide risk was about two after adjustment for various psychosocial confounders.[13]

In this representative, nationwide, general population study we followed 49,398 Swedish conscripts during 35 years, in order to examine whether violent and non-violent offending were related to elevated risk of suicide. We also investigated if the risk was higher among those with repeated offences and how substance abuse and suicide attempt history modified the relationship. Moreover, we studied the choice of suicide methods for the violent and non-violent criminal groups.

This study aimed to address four main research questions:

(1) Do conscripts with violent or non-violent criminality offences differ in respect to risk of suicide?

(2) Does suicide risk increase with repeated offences?

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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

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

MATERIAL AND METHODS

Participants

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

Measures

Measurement of potential confounders

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

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

The confounders were: Father's occupation: social class I+II vs. social class III.

Social class I includes proprietors, private entrepreneurs and high salaried employees in private entrepreneurs and high-income employees in private and public sectors, Social class II other incomes and small entrepreneurs, and social class III mainly blue-collar workers.[22]

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Medication for nervous problems among parents or other members in the family (yes, at least one parent or family member vs. no). Conduct problems at school (at least once vs. no). Any prior contact with police and juvenile authorities (yes at least once vs. no). Having taken medication for psychiatric disorder (at least once vs. no).

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

Intellectual capacity (IQ) was based on four main intellectual and cognitive tests, measuring verbal, logical-inductive, spatial, and technical and mechanical ability. The results of the tests were aggregated in a 5-point summary score for overall intelligence, as described in detail by Ståhlberg[26] and David et al.[27] These scale of intelligence capacity was scored 1=very bad; 2=bad; 3=moderate; 4=good; 5=very good and expressed as intelligence (1–3 vs. 4–5). Details of this procedure and the validity of the assessments have been described by Otto.[23]

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

Measures of alcohol and drug misuse and suicide attempt

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Data from the National Swedish inpatient register were used to identify inpatient care with an alcohol or drug diagnosis of dependence or abuse according to ICD-8 and ICD-9 from 1987 and ICD-10 from 1997 onwards.

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

Suicide

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

Measurement of crime

Data from the National Crime Register were used to identify date, type, and number of criminal offenses. The Crime Register contains information on all convictions in Sweden from 1966 and onwards. Criminality was divided in three categories: no crime, violent crime and non-violent crime. Violence was defined as: homicide, manslaughter and assault and non-violent crime all the

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

other convictions. We also categorized the cohort according to number of crimes meaning for violent and non-violent offenders: (0, 1, and 2 or more crimes).

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

Statistical analyses

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

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

In order to investigate the association between the number of criminal offences and mortality, we categorized subjects according to committed numbers of offences (0, 1, 2 and more) in relation to the time to suicide by using Cox proportional regression analysis. 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 (X) in bivariate and multivariate analyses by using a time-dependent explanatory variable in the model (X*(log time – average value of the log time)). If the p-value was significant ($p<.05$) the proportional hazard assumption was not fulfilled and the variable was not included in the analyses.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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 subjects (5.5%) died during the follow-up period. Of these 615 (23.6%) died due to suicide (474 determined and 141 undetermined). Suicide was more prevalent in the criminal groups: no criminality (4.11%), non-violent (7.3%) and violent criminality (13.7%).

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 prior 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.

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-violent criminal group had almost three times higher 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.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Crude and multivariate analyses

Violent related criminality hade 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.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

A main finding was that nearly one third of the death cases were due to suicide in those who had ever committed a violent offence and one fourth in the non-violent group. This is in line with earlier studies reporting high proportionate mortality among homicide offenders and among personality-disordered offenders subject to forensic psychiatric assessment.[28-30]

Another main finding was that violent offenders had nearly five times higher crude risk and non-violent offenders more than two-fold higher risk for suicide compared to non-criminals. Even after controlling for multiple confounders measured at conscription the hazard ratios remained significant. Alcohol and substance misuse and attempted suicide in the fully adjusted model were confounding on suicide and only association between non-violent offending and suicide remained significant. This implies a strong association between these clinical predictors and suicide risk.[11,31] However, we do not have knowledge about the time order between criminality and the clinical factors measured during the follow-up period, why we have to take the results with cautions.

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.[32] Very few earlier studies on the association between violent and non-violent criminality and suicide have been conducted in a cohort representing the general population and with a long follow-up period. However, national data from England and Wales found after age standardization, 9- to 13-fold increased risk for suicide in both prisoners and non-custody offenders.[32]

We found the suicide cases were rather equally distributed throughout the 35 years follow-up period which probably means that all age categories seem to be vulnerable for suicide. Other studies have shown that the yearly incidence rates of suicide have not shown a clear decrease in the younger age categories in Sweden, why it is important to identify delinquency at young ages and other risk factors in order to find preventive strategies for this group.[5] Generally, suicide

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

rates are higher among the older age groups, often due to loneliness, anxiety disorder and depression.[33-34]

Another finding was that poisoning as method of completed suicide was most prevalent in violent and non-violent criminals, while hanging was the most prevalent method among non-criminals. That was also the case for men in the whole of Sweden.[35] In a Danish national register study of 9708 suicide cases and 188,134 age and gender matched living controls, hanging was the leading suicide method among men, while poisoning among women.[36-37] 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.

Suicide attempt and alcohol misuse

We found that one third of the violent offenders were already diagnosed at conscription with a psychiatric diagnosis. Psychiatric disorders are strongly related to suicide risk, whereas the association between mental illness and violent crime is not as evident. King and Barraclough [38] found 27 times higher risk of unnatural death (suicide, accident and undetermined) among individuals who had recently been in contact with psychiatric clinics compared to those who had not. Persons with severe psychiatric disorders like affective disorder and schizophrenia have highly elevated lifetime suicide risk.[39-40]

One out of five suicide victims in this study had attempted suicide, confirming a strong association between suicide attempt and suicide. This was especially evident for violent offenders where one in three had attempted suicide. 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.[41] In the total cohort, we found that 1192 men (2.4%), had attempted suicide which could be considered as rather low frequency when comparing with the suicides (n=615). An American national study (National Survey on Drug Use and Health), based on interviews and

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

web-questionnaires from 92,264 respondents in year 2008 and 2009, found one suicide case for every 25 attempted suicides.[42] We had data on only suicide attempts needing inpatient care, namely serious suicide attempts, which could explain the ratio. We did not have data on attempted suicides that not turn up as hospital records. Some suicide attempters do not search help at any care givers.[43-44]

In the present study, about half of the violent offenders had reported either risky alcohol or substance use at the time of conscription and nearly one third had been treated at hospital for an alcohol related diagnosis. Alcohol misuse has also been pointed out as an important risk factor for suicide and in some studies the second most common diagnostic group.[33,45] Wilcox et al.[16] found alcohol misusers having a 10-fold increase risk for suicide in a mixed-age cohort. Likewise, in a longitudinal cohort study by Flensborg-Madsen et al.[45] individuals with alcohol use disorders had eight times higher hazard ratios of suicide compared to individuals with no alcohol use. The hazard ratio fell to three after adjustment of psychiatric disorders. These findings indicate the importance of early detection and prevention strategies and treatment for substance users and especially those with suicidal tendencies in all ages.[34] The relationship between alcohol use and violence seems to be complex.[46] The fact that the suicide rate is somewhat higher in the violent criminals than non-violent criminals, one could assume that alcohol misuse play an important role for both violence and suicide.[45]

Advantages and limitations

An advantage of this study is the large national cohort with a longitudinal design and with several adolescent confounders. Only a small part 2-3 % of the conscripts was excluded from the study mainly because of physical or psychiatric disorders. The two questionnaires used at conscription were non-anonymous, which could have contributed 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

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

found good agreement between the different sources of data. [24] A small number of the conscripts missed one or some of the items in the questionnaires. That was especially evident for those subjects who had committed violent offences whereas the response rate for the confounders included in the study varied from 0.26 to 9.45%. The corresponding measures for other criminality and non-criminals were: 0.20 to 6.37% and 0.13 to 4.19%. The violent offenders had probably more severe risk factors than the non-violent and non-criminal groups which could have resulting in underestimating of the hazard ratios of suicide. One could assume that these subjects also had higher rates of substance use and other maladjusted behaviour measured at conscription which in turn could have affected the outcome.[47] However, we have no reason to believe that the risk for the outcome, suicide, has been considerable affected due the internal missing data.

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

Conclusions

We found that individuals registered for either violent or other criminality are at increased risk for committing suicide and that is especially evident for those who were criminal repeaters. However, after adjusting for confounders measured at conscription the risk was still elevated and just slightly significant or non-significant in the fully adjusted model including hospitalization due to alcohol and substance misuse and suicide attempt. The two criminal groups were more likely to use poisoning as suicide method indicating prior experiences of substance misuse. Hanging was most prevalent in the non-criminal group which is in line with the general population in Sweden. [35] We suggest that authorities and the health care should observe the increased risk for suicide in both violent and non-violent criminals, especially those with earlier suicide attempt and comorbid alcohol and substance misuse.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Acknowledgements We want to thank statistician Anders Leifman for the valuable statistical advice.

Competing interests: none.

Funding: The research for this study was supported by Co-ordination of the Swedish Drug Policy (Dnr 238/2006:18), by the Swedish Research Council (Project numbers: K2009-61P-21304-04-4; K2009-61X-21305-01-1) and through the regional agreement on medical training and clinical research (ALF) between Stockholm County Council and Karolinska Institutet, Stockholm Centre for Psychiatric Research and Education.

Contributors: MS planned the study, conducted the statistical analyses and wrote the final version of the manuscript. AS contributed to the planning and data analyses. JJ and AR contributed to the planning of the study and preparing of the manuscript. All authors contributed to the final draft of the manuscript.

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

Data sharing: No additional data available.

Figure legend:

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

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Reference

1. World Health Organization, World suicide prevention day 2012. http://www. who.int/mediacentre/events/annual/ world suicide prevention day/en/

1. Bertolote JM, Fleischmann A. A global perspective on the magnitude of suicide mortality. In: D Wasserman and C Wasserman (eds.). Oxford Textbook of Suicidology and Suicide Prevention: a global perspective. Oxford: Oxford University Press.2009;91-98.

2. Patton GC, Coffey C, Sawyer SM et al. Global patterns of mortality in young people: a systematic analysis of population health data. Lancet 2009;**374**: 881-892.

3. Karimina A, Law MG, Butler TG et al. Suicide risk among recently released prisoners in New South Wales, Australia. Med J Aust 2007;**18**:387-390.

4. Fazel S, Benning R, Danesh J. Suicides in male prisoners in England and Wales, 1978-2003. Lancet 2005;**366**:1301-2.

5. Webb R, Qin P, Stevens H. National study of suicide in all people with a criminal justice history. Arch Gen Psychiatr 2011;**68**,591-9.

6. Hayes LM. National study of jail suicides: seven year later. Psychiatr Q 1989;**60**:7-29.

7. Boardman AP, Grimbaldeston AH, Handley C. et. al. The North Staffordshire Suicide Study: a case-control study of suicide in one health district. Psychol Med 1999;**29:**27- 33.

8. Linsley KR, Johnson N, Martin J. Police contact within 3 months of suicide and associated health service contact. Br J Psychiatry 2007;**190**:170-1.

9. Björkenstam E, Björkenstam C, Vinnerljung B et al. Juvenile delinquency, social background-a Swedish national cohort study of 992881 young adults. Int J Epidemiol 2011;**40**:1585-92.

10. Harris EC, Barraclough B. Suicide as an outcome for mental disorders. A meta-analysis. Br J Psychiatry 1997;**170**:205-28.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

11. Tidemalm D, Långström N, Lichtenstein P. et al., Risk of suicide after suicide attempt according to coexisting psychiatric disorder: Swedish cohort study with long term follow-up. BMJ 2008;**337**:a2205doi:10.1136/bmj.a2205.

12. Runeson B, Tidemalm D, Dahlin M et al. Method of attempted suicide as predictor of subsequent successful suicide: national long term cohort study. BMJ 2010; **340**:c3222doi:10.1136/bmj.c3222.

13. Stenbacka M, Moberg T, Romelsjö A et al. Mortality and causes of death among violent offenders and victims - a Swedish population based longitudinal study. BMC public health 2012;**12:**1-10.

14. Darke S, Douflou J, Torok M. Toxicology and circumstances of completed suicide by means other than overdose. J Forensic Sci 2009;**54**:490-4.

15. Darke S, Duflou J, Totok M. Toxicology and characteristics of fatal oxycodone toxicity cases in New South Wales, Australia 1999-2008. J Forensic Sci 2011;**56**:690-3.

16. Wilcox HC, Conner KR, Caine ED. Association of alcohol and drug use disorders and completed suicide: an empirical review of cohort studies. Drug Alc Depend 2004;**7**:11-19.

17. Allebeck P, Allgulander C, Fisher LD. Predictors of completed suicide in a cohort of 50465 young men: role of personality and deviant behaviour. BMJ 1988;**297**:176-178.

18. Andreasson S, Allebeck P, Romelsjo A. Alcohol and mortality among young men. Longitudinal study of Swedish conscripts. Br Med J 1988;**296**:1021-5.

19. Eriksson A, Romelsjö A, Stenbacka M. et al. Early risk factors for criminal offending in schizophrenia: a 35-year longitudinal cohort study. Soc Psychiatr Epidemiol. 2011 **46:**925-32.

20. Stenbacka M, Leifman L, Dalal K,et al.. Early Predictors of Injury Mortality among Swedish Conscripts:A 35-Year Follow-up Study. Accid Anal Prev 2011;**43**:228-34.

21. Davstad I, Allebeck P, Leifman A et al. Self-reported drug use and mortality among a nationwide sample of Swedish conscripts – A 35-year follow-up. Drug Alc Depend 2011;

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

22. Uppmark M, Karlsson G, Romelsjö A. Drink driving and criminal behaviours as risk factors for receipt of disability pension and sick leave: a prospective study of young men. Addiction 94:507-19.**118**:383-90.

23. Otto U: Male youths. A sociopsychiatric study of a total annual population of Swedish adolescent boys. Acta Psychiatr Scand 1976;Suppl **264**:1-312.

24. Benson G, Holmberg MB: Validity of questionnaire in population studies on drug use. Acta Psychiatr Scand 1985;**70**:9-18.

25. Rydelius P-A. Alcohol-abusing teenage boys. Acta Psychiatr Scand 1983;**68**:368-80.

26. Ståhlberg B. I-provet (intelligence test: the Swedish enlistment battery). Karlstad. Militärpsykologiska Institutet.1971. (In Swedish)

27. David AS, Malmberg L, Brandt L et al. 1997. IQ and risk for schizophrenia: a population-based cohort study. Psychol Med 1997;**27**:1311–23.

28. Kullgren G, Tengström A, Grann M. Suicide among personality-disordered offenders: a follow-up study of 1943 male criminal offenders. Psychiatr Epidemiol 1998;**33**:102-6.

29. Jokinen J, Forslund K, Nordström AL et al. Suicide risk after homicide in Sweden. Arch Suicide Res 2009; **13**:297-301.

30. Jokinen J, Forslund K, Ahnemark E et al. Karolinska Interpersonal Violence Scale predicts suicide in suicide attempters**.** J Clin Psychiatry 2010; **71:**1025-1032.

31. Waern M. Risk factors for suicide in the elderly: What do we know? What do we need to find out? Suicidologi 2011;**16**:2:3-8.

32. Sattar G. Rates and causes of death among prisoners and offenders under community supervision. Home Office Research Study. London Home Office. 2001;231.

33. Waern M. Alcohol dependence and abuse in elderly suicides. Alcohol and Alcoholism 2003;38:249-254.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

34. Whiteford HA, Degenhardt L, Rehm J et al. Global burden of disease attributable to mental and substance use disorders: findings from the Global Burden of Disease Study 2010. Lancet 2013;28. doi:pii: S0140-6736(13)61611-6. 10.1016/S0140-6736(13)61611-6.

35.National Board on Health and Welfare, The Cause of Death Register, 2012.

36. Webb RT, Qin P, Stevens H, Shaw J, Appleby L, Mortensen PB. National study of suicide method in violent criminal offenders. J Affect Disord 2013; [http://dx.doi.org/ 10.1016/j.jad.2013.04.001].

37. Titelman D, Oskarsson H, Wahlbeck K et al. Suicide mortality trends in the Nordic countries 1980–2009. Nord J Psychiatry 2013;1–10.23293897.

38. King E, Barraclough B. Violent death and mental illness: A study of a single catchment area over eight years. Br J Psychiatry 1990;**156**;714-20.

39.Carlborg A,Winnerbäck K, Jönson EG. et al. Suicide in schizophrenia. Expert Review of Neurotherapeutics 2010;**10**,1153–1164.

40. Nordentoft M, Mortensen PB, Pedersen CB. Absolute risk of suicide after first hospital contact in mental disorder. Arch Gen Psychiatry. 2011;**68**(10):1058-64.

41. Suominen K, Isometsa E, Suokas J et al. Completed suicide after a suicide attempt: a 37-year follow-up study. Am J Psychiatry 2004;**161**:562-563.

42.Crosby AE, Han B, Ortega LAG et al. Suicidal thoughts and behaviors among adults aged ≥18 years-United States, 2008-2009. MMWR Surveillance Summaries 2011;60(no. SS-13).

43. Guilherme B, Jules A, Nock MK et al. Risk factors for twelve-month suicide attempts in the National Comorbidity Survey Replication (NCS-R). Psychol Med 2006;**36**:1747–57.

44. De Leo D, Ester C, Kym S et al. Lifetime risk of suicide ideation and attempts in an Australian community: Prevalence, suicidal process, and help-seeking behaviour. 2005;**86:**215–24.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

45. Flensborg-Madsen T, Knop J, Mortensen EL et al. Alcohol use disorders increase the risk of completed suicide—Irrespective of other psychiatric disorders. A longitudinal cohort study. Psychiatry Research 2009;**167**;123–130.

46. Lipsey MW, Wilson DB, Cohen MA, Derzon JH: Is there a causal relationship between alcohol use and violence? A synthesis of evidence. Recent Dev Alcohol 1997;**13**:245-82.

47. Stattin H, Romelsjö R, Stenbacka M. Personal resources as modifiers of the risk for future criminality: an analysis of protective factors in relation to 18-year-old boys. Br J Criminol 1997;**37:**198–223.

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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)	
1-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

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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 conscription)				
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)	

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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 Non-violent crime Violent crime	1.0 2.94, 2.26-3.81 6.92, 4.91-9.76
Hanging/suffocation (n=149): E953, E983, X70, Y20	No crime Non-violent crime Violent crime	1.0 1.28, 0.90-1.83 2.54, 1.47-4.40
Firearm (n=69): E955,E985, X722-X74, Y422-Y424	No crime Non-violent crime Violent crime	1.0 1.39, 0.83-2.34 3.08, 1.44-6.60
Drowning (n=41): E954, E984, X71,Y21	No crime Non-violent crime Violent crime	1.0 1.62, 0.82-3.20 5.17, 2.19-12.24
Jump from heights (n=27): E957, E987, X80, Y30	No crime Non-violent crime Violent crime	1.0 3.23,1.43-7.26 4.41, 1.21-16.00
Moving train (n=22): E9580, E9880, X81, Y31	No crime Non-violent crime Violent crime	1.0 2.07, 0.84- 5.10 4.40, 1.21- 15.98
Cutting (n=16): E956, E986,X79,Y28	No crime Non-violent crime Violent crime	1.0 4.61, 1.58-13.50 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 Non-violent crime Violent crime	1.0 2.32, 0.67-8.01 8.99, 2.15-37.63

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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.

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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

[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.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Criminality and Suicide–A longitudinal Swedish Cohort Study

Stenbacka M.,1,2) Sidorchuk A.,2) Romelsjö A.,2) Jokinen J.,3)

1). Addiction Center Stockholm, S:t Eriks Hospital Polhemsgatan 60, 112 82 Stockholm, Sweden.

2). Department of Public Health Sciences, Karolinska Institute, Widerströmska Building, 171 76 Stockholm, Sweden.

3). Department of Clinical Neuroscience, Karolinska Institute, Karolinska University Hospital Solna, 171 76 Stockholm, Sweden.

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

Word count: 3640

For peer review only

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

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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.

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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]

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

In a Swedish national register based study, it was found that patients who had attempted suicide by hanging evinced highest risk for 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 more prevalent in substance users than in the general population. For instance, Darke et al.[15] found that about one third of the substance misusers had experiences of suicide attempts. Suicide among opioid misusers has been estimated to be 14 times higher than the general population.[10,16] Further, one fifth or more of the suicide cases had substances presented in the blood in one study.[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 significantly associated with high rate of suicide.[17] Likewise, a longitudinal study of offenders and victims of violence and cause specific mortality showed that the hazard ratio for suicide risk was about two after adjustment for various psychosocial confounders.[13]

In this representative, nationwide, general population study we followed 49,398 Swedish conscripts during 35 years, in order to examine whether violent and non-violent offending were related to elevated risk of suicide. We also investigated if the risk was higher among those with repeated offences and how substance abuse and suicide attempt history modified the relationship. Moreover, we studied the choice of suicide methods for the violent and non-violent criminal groups.

This study aimed to address four main research questions:

(1) Do conscripts with violent or non-violent criminality offences differ in respect to risk of suicide?

(2) Does suicide risk increase with repeated offences?

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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

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

MATERIAL AND METHODS

Participants

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

Measures

Measurement of potential confounders

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

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

The confounders were: Father's occupation: social class I+II vs. social class III.

Social class I includes proprietors, private entrepreneurs and high salaried employees in private entrepreneurs and high-income employees in private and public sectors, Social class II other incomes and small entrepreneurs, and social class III mainly blue-collar workers.[22]

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Medication for nervous problems among parents or other members in the family (yes, at least one parent or family member vs. no). Conduct problems at school (at least once vs. no). Any prior contact with police and juvenile authorities (yes at least once vs. no). Having taken medication for psychiatric disorder (at least once vs. no).

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

Intellectual capacity (IQ) was based on four main intellectual and cognitive tests, measuring verbal, logical-inductive, spatial, and technical and mechanical ability. The results of the tests were aggregated in a 5-point summary score for overall intelligence, as described in detail by Ståhlberg[26] and David et al.[27] These scale of intelligence capacity was scored 1=very bad; 2=bad; 3=moderate; 4=good; 5=very good and expressed as intelligence (1–3 vs. 4–5). Details of this procedure and the validity of the assessments have been described by Otto.[23]

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

Measures of alcohol and drug misuse and suicide attempt

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Data from the National Swedish inpatient register were used to identify inpatient care with an alcohol or drug diagnosis of dependence or abuse according to ICD-8 and ICD-9 from 1987 and ICD-10 from 1997 onwards.

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

Suicide

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

Measurement of crime

Data from the National Crime Register were used to identify date, type, and number of criminal offenses. The Crime Register contains information on all convictions in Sweden from 1966 and onwards. Criminality was divided in three categories: no crime, violent crime and non-violent crime. Violence was defined as: homicide, manslaughter and assault and non-violent crime all the

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

other convictions. We also categorized the cohort according to number of crimes meaning for violent and non-violent offenders: (0, 1, and 2 or more crimes).

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

Statistical analyses

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

We had no exact information whether a person had emigrated from Sweden or not during the follow-up period, therefore we could not censor for emigration in the calculation of person time. In order to investigate the association between the number of criminal offences and mortality, we categorized subjects according to committed numbers of offences (0, 1, 2 and more) in relation to the time to suicide by using Cox proportional regression analysis. 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 (X) in bivariate and multivariate analyses by using a time-dependent explanatory variable in the model (X*(log time – average value of the log time)). If the p-value was significant ($p<.05$) the proportional hazard assumption was not fulfilled and the variable was not included in the analyses.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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 subjects (5.5%) died during the follow-up period. Of these 615 (23.6%) died due to suicide (474 determined and 141 undetermined). Suicide was more prevalent in the criminal groups: no criminality (4.11%), non-violent (7.3%) and violent criminality (13.7%).

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 prior 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.

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-violent criminal group had almost three times higher 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.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Crude and multivariate analyses

Violent related criminality hade 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.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

A main finding was that nearly one third of the death cases were due to suicide in those who had ever committed a violent offence and one fourth in the non-violent group. This is in line with earlier studies reporting high proportionate mortality among homicide offenders and among personality-disordered offenders subject to forensic psychiatric assessment.[28-30]

Another main finding was that violent offenders had nearly five times higher crude risk and non-violent offenders more than two-fold higher risk for suicide compared to non-criminals. Even after controlling for multiple confounders measured at conscription the hazard ratios remained significant. Alcohol and substance misuse and attempted suicide in the fully adjusted model were confounding on suicide and only association between non-violent offending and suicide remained significant. This implies a strong association between these clinical predictors and suicide risk.[11,31] However, we do not have knowledge about the time order between criminality and the clinical factors measured during the follow-up period, why we have to take the results with cautions.

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.[32] Very few earlier studies on the association between violent and non-violent criminality and suicide have been conducted in a cohort representing the general population and with a long follow-up period. However, national data from England and Wales found after age standardization, 9- to 13-fold increased risk for suicide in both prisoners and non-custody offenders.[32]

We found the suicide cases were rather equally distributed throughout the 35 years follow-up period which probably means that all age categories seem to be vulnerable for suicide. Other studies have shown that the yearly incidence rates of suicide have not shown a clear decrease in the younger age categories in Sweden, why it is important to identify delinquency at young ages and other risk factors in order to find preventive strategies for this group.[5] Generally, suicide

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

rates are higher among the older age groups, often due to loneliness, anxiety disorder and depression.[33-34]

Another finding was that poisoning as method of completed suicide was most prevalent in violent and non-violent criminals, while hanging was the most prevalent method among non-criminals. That was also the case for men in the whole of Sweden.[35] In a Danish national register study of 9708 suicide cases and 188,134 age and gender matched living controls, hanging was the leading suicide method among men, while poisoning among women.[36-37] 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.

Suicide attempt and alcohol misuse

We found that one third of the violent offenders were already diagnosed at conscription with a psychiatric diagnosis. Psychiatric disorders are strongly related to suicide risk, whereas the association between mental illness and violent crime is not as evident. King and Barraclough [38] found 27 times higher risk of unnatural death (suicide, accident and undetermined) among individuals who had recently been in contact with psychiatric clinics compared to those who had not. Persons with severe psychiatric disorders like affective disorder and schizophrenia have highly elevated lifetime suicide risk.[39-40]

One out of five suicide victims in this study had attempted suicide, confirming a strong association between suicide attempt and suicide. This was especially evident for violent offenders where one in three had attempted suicide. 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.[41] In the total cohort, we found that 1192 men (2.4%), had attempted suicide which could be considered as rather low frequency when comparing with the suicides (n=615). An American national study (National Survey on Drug Use and Health), based on interviews and

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

web-questionnaires from 92,264 respondents in year 2008 and 2009, found one suicide case for every 25 attempted suicides.[42] We had data on only suicide attempts needing inpatient care, namely serious suicide attempts, which could explain the ratio. We did not have data on attempted suicides that not turn up as hospital records. Some suicide attempters do not search help at any care givers.[43-44]

In the present study, about half of the violent offenders had reported either risky alcohol or substance use at the time of conscription and nearly one third had been treated at hospital for an alcohol related diagnosis. Alcohol misuse has also been pointed out as an important risk factor for suicide and in some studies the second most common diagnostic group.[33,45] Wilcox et al.[16] found alcohol misusers having a 10-fold increase risk for suicide in a mixed-age cohort. Likewise, in a longitudinal cohort study by Flensborg-Madsen et al.[45] individuals with alcohol use disorders had eight times higher hazard ratios of suicide compared to individuals with no alcohol use. The hazard ratio fell to three after adjustment of psychiatric disorders. These findings indicate the importance of early detection and prevention strategies and treatment for substance users and especially those with suicidal tendencies in all ages.[34] The relationship between alcohol use and violence seems to be complex.[46] The fact that the suicide rate is somewhat higher in the violent criminals than non-violent criminals, one could assume that alcohol misuse play an important role for both violence and suicide.[45]

Advantages and limitations

An advantage of this study is the large national cohort with a longitudinal design and with several adolescent confounders. Only a small part 2-3 % of the conscripts was excluded from the study mainly because of physical or psychiatric disorders. The two questionnaires used at conscription were non-anonymous, which could have contributed 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

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

found good agreement between the different sources of data. [24] A small number of the conscripts missed one or some of the items in the questionnaires. That was especially evident for those subjects who had committed violent offences whereas the response rate for the confounders included in the study varied from 0.26 to 9.45%. The corresponding measures for other criminality and non-criminals were: 0.20 to 6.37% and 0.13 to 4.19%. The violent offenders had probably more severe risk factors than the non-violent and non-criminal groups which could have resulting in underestimating of the hazard ratios of suicide. One could assume that these subjects also had higher rates of substance use and other maladjusted behaviour measured at conscription which in turn could have affected the outcome.[47] However, we have no reason to believe that the risk for the outcome, suicide, has been considerable affected due the internal missing data.

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

Conclusions

We found that individuals registered for either violent or other criminality are at increased risk for committing suicide and that is especially evident for those who were criminal repeaters. However, after adjusting for confounders measured at conscription the risk was still elevated and just slightly significant or non-significant in the fully adjusted model including hospitalization due to alcohol and substance misuse and suicide attempt. The two criminal groups were more likely to use poisoning as suicide method indicating prior experiences of substance misuse. Hanging was most prevalent in the non-criminal group which is in line with the general population in Sweden. [35] We suggest that authorities and the health care should observe the increased risk for suicide in both violent and non-violent criminals, especially those with earlier suicide attempt and comorbid alcohol and substance misuse.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Acknowledgements We want to thank statistician Anders Leifman for the valuable statistical advice.

Competing interests: none.

Funding: The research for this study was supported by Co-ordination of the Swedish Drug Policy (Dnr 238/2006:18), by the Swedish Research Council (Project numbers: K2009-61P-21304-04-4; K2009-61X-21305-01-1) and through the regional agreement on medical training and clinical research (ALF) between Stockholm County Council and Karolinska Institutet, Stockholm Centre for Psychiatric Research and Education.

Contributors: MS planned the study, conducted the statistical analyses and wrote the final version of the manuscript. AS contributed to the planning and data analyses. JJ and AR contributed to the planning of the study and preparing of the manuscript. All authors contributed to the final draft of the manuscript.

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

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Reference

1. World Health Organization, World suicide prevention day 2012. http://www. who.int/mediacentre/events/annual/ world suicide prevention day/en/

1. Bertolote JM, Fleischmann A. A global perspective on the magnitude of suicide mortality. In: D Wasserman and C Wasserman (eds.). Oxford Textbook of Suicidology and Suicide Prevention: a global perspective. Oxford: Oxford University Press.2009;91-98.

2. Patton GC, Coffey C, Sawyer SM et al. Global patterns of mortality in young people: a systematic analysis of population health data. Lancet 2009;**374**: 881-892.

3. Karimina A, Law MG, Butler TG et al. Suicide risk among recently released prisoners in New South Wales, Australia. Med J Aust 2007;**18**:387-390.

4. Fazel S, Benning R, Danesh J. Suicides in male prisoners in England and Wales, 1978-2003. Lancet 2005;**366**:1301-2.

5. Webb R, Qin P, Stevens H. National study of suicide in all people with a criminal justice history. Arch Gen Psychiatr 2011;**68**,591-9.

6. Hayes LM. National study of jail suicides: seven year later. Psychiatr Q 1989;**60**:7-29.

7. Boardman AP, Grimbaldeston AH, Handley C. et. al. The North Staffordshire Suicide Study: a case-control study of suicide in one health district. Psychol Med 1999;**29:**27- 33.

8. Linsley KR, Johnson N, Martin J. Police contact within 3 months of suicide and associated health service contact. Br J Psychiatry 2007;**190**:170-1.

9. Björkenstam E, Björkenstam C, Vinnerljung B et al. Juvenile delinquency, social background-a Swedish national cohort study of 992881 young adults. Int J Epidemiol 2011;**40**:1585-92.

10. Harris EC, Barraclough B. Suicide as an outcome for mental disorders. A meta-analysis. Br J Psychiatry 1997;**170**:205-28.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

11. Tidemalm D, Långström N, Lichtenstein P. et al., Risk of suicide after suicide attempt according to coexisting psychiatric disorder: Swedish cohort study with long term follow-up. BMJ 2008;**337**:a2205doi:10.1136/bmj.a2205.

12. Runeson B, Tidemalm D, Dahlin M et al. Method of attempted suicide as predictor of subsequent successful suicide: national long term cohort study. BMJ 2010; **340**:c3222doi:10.1136/bmj.c3222.

13. Stenbacka M, Moberg T, Romelsjö A et al. Mortality and causes of death among violent offenders and victims - a Swedish population based longitudinal study. BMC public health 2012;**12:**1-10.

14. Darke S, Douflou J, Torok M. Toxicology and circumstances of completed suicide by means other than overdose. J Forensic Sci 2009;**54**:490-4.

15. Darke S, Duflou J, Totok M. Toxicology and characteristics of fatal oxycodone toxicity cases in New South Wales, Australia 1999-2008. J Forensic Sci 2011;**56**:690-3.

16. Wilcox HC, Conner KR, Caine ED. Association of alcohol and drug use disorders and completed suicide: an empirical review of cohort studies. Drug Alc Depend 2004;**7**:11-19.

17. Allebeck P, Allgulander C, Fisher LD. Predictors of completed suicide in a cohort of 50465 young men: role of personality and deviant behaviour. BMJ 1988;**297**:176-178.

18. Andreasson S, Allebeck P, Romelsjo A. Alcohol and mortality among young men. Longitudinal study of Swedish conscripts. Br Med J 1988;**296**:1021-5.

19. Eriksson A, Romelsjö A, Stenbacka M. et al. Early risk factors for criminal offending in schizophrenia: a 35-year longitudinal cohort study. Soc Psychiatr Epidemiol. 2011 **46:**925-32.

20. Stenbacka M, Leifman L, Dalal K,et al.. Early Predictors of Injury Mortality among Swedish Conscripts:A 35-Year Follow-up Study. Accid Anal Prev 2011;**43**:228-34.

21. Davstad I, Allebeck P, Leifman A et al. Self-reported drug use and mortality among a nationwide sample of Swedish conscripts – A 35-year follow-up. Drug Alc Depend 2011;

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

22. Uppmark M, Karlsson G, Romelsjö A. Drink driving and criminal behaviours as risk factors for receipt of disability pension and sick leave: a prospective study of young men. Addiction 94:507-19.**118**:383-90.

23. Otto U: Male youths. A sociopsychiatric study of a total annual population of Swedish adolescent boys. Acta Psychiatr Scand 1976;Suppl **264**:1-312.

24. Benson G, Holmberg MB: Validity of questionnaire in population studies on drug use. Acta Psychiatr Scand 1985;**70**:9-18.

25. Rydelius P-A. Alcohol-abusing teenage boys. Acta Psychiatr Scand 1983;**68**:368-80.

26. Ståhlberg B. I-provet (intelligence test: the Swedish enlistment battery). Karlstad. Militärpsykologiska Institutet.1971. (In Swedish)

27. David AS, Malmberg L, Brandt L et al. 1997. IQ and risk for schizophrenia: a population-based cohort study. Psychol Med 1997;**27**:1311–23.

28. Kullgren G, Tengström A, Grann M. Suicide among personality-disordered offenders: a follow-up study of 1943 male criminal offenders. Psychiatr Epidemiol 1998;**33**:102-6.

29. Jokinen J, Forslund K, Nordström AL et al. Suicide risk after homicide in Sweden. Arch Suicide Res 2009; **13**:297-301.

30. Jokinen J, Forslund K, Ahnemark E et al. Karolinska Interpersonal Violence Scale predicts suicide in suicide attempters**.** J Clin Psychiatry 2010; **71:**1025-1032.

31. Waern M. Risk factors for suicide in the elderly: What do we know? What do we need to find out? Suicidologi 2011;**16**:2:3-8.

32. Sattar G. Rates and causes of death among prisoners and offenders under community supervision. Home Office Research Study. London Home Office. 2001;231.

33. Waern M. Alcohol dependence and abuse in elderly suicides. Alcohol and Alcoholism 2003;38:249-254.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

34. Whiteford HA, Degenhardt L, Rehm J et al. Global burden of disease attributable to mental and substance use disorders: findings from the Global Burden of Disease Study 2010. Lancet 2013;28. doi:pii: S0140-6736(13)61611-6. 10.1016/S0140-6736(13)61611-6.

35.National Board on Health and Welfare, The Cause of Death Register, 2012.

36. Webb RT, Qin P, Stevens H, Shaw J, Appleby L, Mortensen PB. National study of suicide method in violent criminal offenders. J Affect Disord 2013; [http://dx.doi.org/ 10.1016/j.jad.2013.04.001].

37. Titelman D, Oskarsson H, Wahlbeck K et al. Suicide mortality trends in the Nordic countries 1980–2009. Nord J Psychiatry 2013;1–10.23293897.

38. King E, Barraclough B. Violent death and mental illness: A study of a single catchment area over eight years. Br J Psychiatry 1990;**156**;714-20.

39.Carlborg A,Winnerbäck K, Jönson EG. et al. Suicide in schizophrenia. Expert Review of Neurotherapeutics 2010;**10**,1153–1164.

40. Nordentoft M, Mortensen PB, Pedersen CB. Absolute risk of suicide after first hospital contact in mental disorder. Arch Gen Psychiatry. 2011;**68**(10):1058-64.

41. Suominen K, Isometsa E, Suokas J et al. Completed suicide after a suicide attempt: a 37-year follow-up study. Am J Psychiatry 2004;**161**:562-563.

42.Crosby AE, Han B, Ortega LAG et al. Suicidal thoughts and behaviors among adults aged ≥18 years-United States, 2008-2009. MMWR Surveillance Summaries 2011;60(no. SS-13).

43. Guilherme B, Jules A, Nock MK et al. Risk factors for twelve-month suicide attempts in the National Comorbidity Survey Replication (NCS-R). Psychol Med 2006;**36**:1747–57.

44. De Leo D, Ester C, Kym S et al. Lifetime risk of suicide ideation and attempts in an Australian community: Prevalence, suicidal process, and help-seeking behaviour. 2005;**86:**215–24.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

45. Flensborg-Madsen T, Knop J, Mortensen EL et al. Alcohol use disorders increase the risk of completed suicide—Irrespective of other psychiatric disorders. A longitudinal cohort study. Psychiatry Research 2009;**167**;123–130.

46. Lipsey MW, Wilson DB, Cohen MA, Derzon JH: Is there a causal relationship between alcohol use and violence? A synthesis of evidence. Recent Dev Alcohol 1997;**13**:245-82.

47. Stattin H, Romelsjö R, Stenbacka M. Personal resources as modifiers of the risk for future criminality: an analysis of protective factors in relation to 18-year-old boys. Br J Criminol 1997;**37:**198–223.

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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)	
1-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

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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 conscription)				
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)	

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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 Non-violent crime Violent crime	1.0 2.94, 2.26-3.81 6.92, 4.91-9.76
Hanging/suffocation (n=149): E953, E983, X70, Y20	No crime Non-violent crime Violent crime	1.0 1.28, 0.90-1.83 2.54, 1.47-4.40
Firearm (n=69): E955,E985, X722-X74, Y422-Y424	No crime Non-violent crime Violent crime	1.0 1.39, 0.83-2.34 3.08, 1.44-6.60
Drowning (n=41): E954, E984, X71,Y21	No crime Non-violent crime Violent crime	1.0 1.62, 0.82-3.20 5.17, 2.19-12.24
Jump from heights (n=27): E957, E987, X80, Y30	No crime Non-violent crime Violent crime	1.0 3.23,1.43-7.26 4.41, 1.21-16.00
Moving train (n=22): E9580, E9880, X81, Y31	No crime Non-violent crime Violent crime	1.0 2.07, 0.84- 5.10 4.40, 1.21- 15.98
Cutting (n=16): E956, E986,X79,Y28	No crime Non-violent crime Violent crime	1.0 4.61, 1.58-13.50 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 Non-violent crime Violent crime	1.0 2.32, 0.67-8.01 8.99, 2.15-37.63

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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.

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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

[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.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

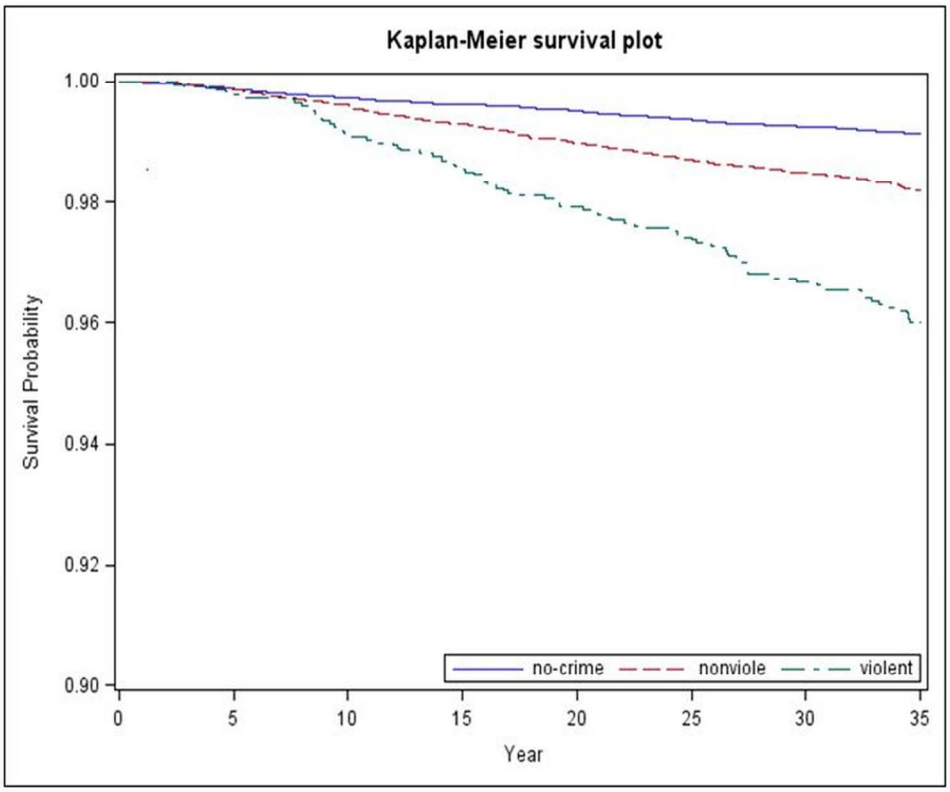


Fig 1. Kaplan-Meier survival plot for suicide in violent and non-violent criminals

101x90mm (300 x 300 DPI)

For peer review 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

For peer review only

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	9-11, 22-26
		(*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	
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.

For peer review only