Predictors of suicide, accidental death, and premature natural death in a general-population birth cohort

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Summary

Background Whether putative suicide risk factors, such as conduct and emotional disorders, are specific to suicide or are general associations of a continuum between subintentional and intentional self-destruction is not clear. We undertook an investigation of this issue in a UK population-based birth cohort.

Methods Using competing-risks analysis, we examined links between prospectively collected childhood and adolescent temperamental and behavioural variables and the risk of natural, accidental, and suicidal death, occurring between the ages of 16 and 50 years. Of the 5362 members of the cohort, full data were available for 3591. A panel of psychiatrists scored deaths on likely suicidal intention. These scores were used in a weighted logistic regression to examine independence of risk factors for (sub)intentional self-destruction.

Findings There were 167 deaths among the risk-set between the 16th and 50th birthdays. 120 were due to natural causes; of the other 47, the panel of psychiatrists judged that 36 were accidental deaths and 11 were suicides (certainty rating ⩾51%). Adolescent emotional instability and conduct problems had different associations with the various causes of premature death, being lowest for natural death (odds ratio 1·0 [95% CI 0·8–1·2] and 1·2 [1·0–1·5]), intermediate for accidental death (1·1 [0·8–1·5] and 1·3 [1·0–1·7]), and highest for suicidal death (2·0 [1·2–3·6] and 1·8 [1·3–2·5]). Emotional instability (boys 1·3 [1·0–1·7], girls 1·4 [1·0–1·9]) increased risk for subintentional or intentional self-destruction, as did low anxiety in adolescence (1·7 [1·3–2·5]) and nocturnal enuresis at age 4 (1·4 [1·2–1·7]) in boys, and conduct problems in girls (1·4 [1·0–2·0]).

Interpretation Suicide shares important risk factors with other causes of premature death. These findings suggest an aetiological continuum of self-destruction from subintentional to intentional. Research on premature mortality associated with psychological disorder should include all causes of death.

Lancet 1998; **351:** 93–97

See Commentary page

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Introduction

Individuals at high risk of suicide, such as those who have previously attempted suicide,[1,2] people with mental illness,[3–5] drug users,[6] and people who underwent psychiatric treatment as children,[7] are also at higher risk of premature natural and accidental death. This association suggests that risk factors for suicide and other causes of death may overlap. This idea has a long history, for example including Freud's death instinct.[8] Faberow[9] proposed an aetiological continuum between suicide and indirect self-destructive behaviours,[1] a collective term for high-risk lifestyles, including drug abuse, risk-taking in driving and sports, and neglect of physical health, all of which may shorten life whether or not conscious suicidal intent is present.[9]

The possibility that suicide risk factors may also raise risk of other types of death has policy implications, because successful suicide prevention among high-risk individuals would, if their risk of other types of death is raised, merely lead to decompression of mortality from alternative causes.[10] However, evidence in favour of aetiological continuity between suicide and other causes of premature death remains circumstantial and mainly based on clinical impression.

Childhood conduct and emotional disorder are known independent risk factors for future suicidal behaviour.[11–13] Using prospectively collected data on childhood and adolescent development in a general-population birth cohort, we examined whether developmental and temperamental characteristics associated with conduct and emotional problems raise risk, not only of suicide but also of premature death from accidents and natural causes, consistent with the hypothesis of a continuum between subintentional and intentional self-destructive behaviour.

Methods

Cohort

The data were obtained from the MRC National Survey of Health and Development, a stratified, random sample (n=5362) of 13 687 births in England, Scotland, and Wales during the week March 3–9, 1946.[14] Information was collected from various sources ten times before the participants were 16 years old; the average follow-up rate rate during this period was 91%.[14]

Deaths of survey members resident in the UK are automatically notified to the survey. By March, 1996 (members' 50th birthday), 424 death certificates had been received. 253 were for people who died when younger than 16 years and were excluded. Childhood and adolescent data were completely missing for 218 individuals (80 lost to follow-up, 12 refused, 126 emigrated), who were also excluded. During follow-up between the 16th and 50th birthdays, 1300 individuals were lost, of whom at least 571 had emigrated.[14] Since completeness of death registration for those lost to follow-up cannot be guaranteed, these individuals were also excluded (although they were used to examine attrition bias). Thus an effective risk-set of 3591 remained.

Within the effective risk-set, there were 167 deaths between the 16th and 50th birthdays; 120 were due to natural causes and
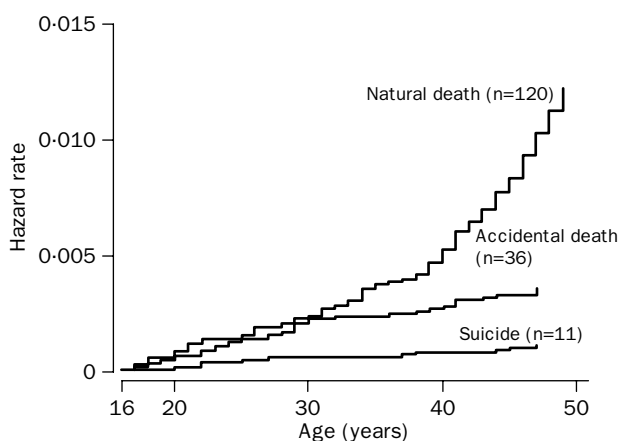
Cumulative death rates (age 16–50 years) by cause of death

47 to unnatural causes (eight suicide, 14 undetermined, and 23 accidental verdicts; two unrecorded verdicts of unnatural death). From information on the certificates of unnatural death, vignettes were prepared (including age, sex, and circumstances of death but no coroner's verdict or biographical details) and circulated to 20 psychiatrists, 17 of whom rated how confidently (0–100%) they would attribute the deaths to suicide. Mean confidence scores, ranging from 7% (pedestrian stuck by van) to 97% (death by hanging), were used to generate the outcome categories for the main analyses—deaths from natural causes (n=120), accidents (mean confidence score ≤50%; n=36), and suicide (mean confidence score ≥51%; n=11).

Risk factors

Cognitive development—At around the participants' 2nd birthdays, mothers rated the age in months at which first comprehensible speech (other than parents' names) had been achieved. During the 7th year, school doctors described their overall alertness in four degrees. Aged 15, children completed verbal, non-verbal, motor, and general ability tests; a principal component, which we called intelligence, accounted for 82% of the variance of these test scores. Academic achievement (public examinations passed) around the 16th birthday was recorded.

Physical development—At around the participants' 2nd birthdays, mothers rated the age in months at first standing, walking, and sitting unaided. A principal component (motor milestones) accounted for 74% of the variance of these ages. Mothers also rated, around the participants' 4th birthdays, occurrence and frequency of nocturnal enuresis. Global impressions of physical development (in three categories—inferior, average, superior) were recorded by medical examiners around the 2nd and 11th birthdays.

Observed socioemotional development—Teachers rated, around the 13th birthday, presence of aggressive behaviour and habits/tics on scales with seven severity categories. Around the 15th birthday, teachers completed a questionnaire about children's behaviour with 17 items (three severity categories each) ranging from roughness and disobedience to undue shyness and anxiety. This questionnaire yielded two interpretable principal components, the first representing conduct problems and the second low anxiety.[15]

Emotional development—Aged 13, members completed a 43-item yes/no personality inventory[16] with subscales for emotional instability (eg, I worry about little mistakes I make), sociability (eg, I feel at home at parties), negativity (eg, most people will tell lies to avoid trouble), and aggression (eg, I can frighten others easily). Factor analysis confirmed the presence of these subscales in the dataset.

Background information was obtained on father's social class

during the child's 4th year, parents' health status before the child's 11th year, psychiatric treatment between the 9th and 15th birthdays, and hospital admissions before the 6th birthday.

Statistical analysis

Agreement about cause of death between coroners and psychiatrists, and among psychiatrists themselves, was examined by means of intra-class correlation. Since baseline hazard rates for the respective outcomes (suicide, accidental death, and natural death) were not proportional, risks of death between the 16th and 50th birthdays were modelled by means of logistic regression, instead of hazard rates. Continuous and ordered predictor variables were standardised so that odds ratios approximate relative risks associated with a shift of 1 SD of the independent variable. In the competing-risks analysis, odds ratios for the respective types of death were calculated and compared. Deaths from causes other than that of interest were treated as censored observations[2,17] so odds ratios for given death categories are independent of competing outcomes.[18] We assessed the effect of suicide misclassification by comparing results of analysis for cases attributed by psychiatrists to suicide with 51% confidence or more (11) or with 76% confidence or more (eight), and the eight cases in which coroners returned suicide verdicts.

Logistic regression, weighted for the confidence with which psychiatrists had attributed deaths to suicide, was used to examine independence of risk factors for (sub)intentional self-destruction. People who died of natural causes and those who survived were weighted as having the lowest-scoring accidental death (pedestrian struck by van). The relevance of this analysis for subintentional or intentional self-destruction was increased by selection of only those variables for which univariate associations with risk of death increased steadily in strength from natural via accidental to suicidal death. The likelihood ratio (LR) test was used to compare the fit of models and to examine whether risk factors acted differently in men and women.

Results

The psychiatrists' average suicide confidence scores were bimodally distributed; 25 (52%) of the 47 unnatural death cases scored below 0·2, and seven (15%) scored above 0·8. The intra-class correlation of the psychiatrists' scores per unnatural death was 0·76 (SD 0·01; p<0·001), and that of the average scores per verdict category (excluding the two unrecorded cases) was 0·76 (0·04; p<0·001).

The life expectancy of the full cohort (5362) was higher than of the entire UK population born in 1946,[19] probably because of exclusion, in initial sampling, of illegitimate births, giving under-representation of lower social classes.[14] The cohort survival probability for 1946–96 was 0·92 (95% CI 0·91–0·93) for men and 0·95 (0·94–0·96) for women, compared with 0·83 and 0·87 for the entire UK population. For the effective risk-set (3591; 16–50 years), hazards were not proportional between the three causes of death (figure). With suicide as the reference category, the hazard rates for accidental death and natural death were 4·0 (1·9–9·8) and 4·5 (1·9–10·9) before the age of 33·5 years and 2·4 (0·9–6·8) and 18·8 (7·6–45·7) after that age.

Risk factors

Suicide—Risk was significantly increased among participants with poor childhood and adolescent physical development, those with nocturnal enuresis until the 4th birthday, and those who, in adolescence, displayed excessive tics, aggression, or conduct problems, and reported high emotional instability (table 1). Low anxiety, low parental social class, poor academic achievement, a

Developmental variable (age)	Odds ratio (95% CI) for:		
	Natural death (n=120)	Accidental death (n=36)	Suicide* (n=11)
Cognitive			
Age at first speech	1·1 (0·9–1·4)	1·7 (1·2–2·5)	0·9 (0·6–1·5)
Low alertness (7)	1·3 (1·1–1·6)	0·8 (0·6–1·2)	1·1 (0·8–1·5)
Low intelligence (15)	1·2 (1·0–1·5)	1·5 (1·1–2·2)	1·1 (0·8–1·7)
Physical			
Motor milestone	1·1 (1·0–1·4)	0·8 (0·5–1·2)	0·8 (0·4–1·5)
Poor physical development (2)	1·3 (1·0–1·5)‡	1·0 (0·7–1·3)	1·4 (1·0–2·0)‡
Poor physical development (11)†	1·3 (1·1–1·7)	1·3 (0·9–1·9)	1·7 (1·2–2·6)
Enuresis (4)†	1·1 (1·0–1·3)	1·4 (1·1–1·6)	1·5 (1·1–2·1)
Socioemotional (teacher-related)			
Aggression (13)†	1·1 (1·0–1·3)	1·2 (1·0–1·5)‡	1·5 (1·1–1·9)
Habits/tics (13)	1·2 (1·1–1·4)	0·8 (0·6–1·3)	1·5 (1·2–1·9)
Conduct problems (15)†	1·2 (1·0–1·5)‡	1·3 (1·0–1·7)	1·8 (1·3–2·5)
Low anxiety (15)†	0·8 (0·7–1·0)‡	1·4 (1·0–2·5)	2·0 (0·8–5·0)
Emotional (self-rated)			
Instability (13)†	1·0 (0·8–1·2)	1·1 (0·8–1·5)	2·0 (1·2–3·6)
Aggression (13)	1·0 (0·9–1·2)	1·4 (1·0–2·0)	1·0 (0·6–1·6)
Negativity (13)	1·1 (0·9–1·3)	1·3 (0·9–1·8)	0·8 (0·4–1·6)
Extraversion (13)	1·1 (0·9–1·3)	1·0 (0·7–1·4)	1·4 (0·5–3·4)
Background variables			
Parental social class†§	1·7 (1·1–2·6)	1·7 (0·8–3·6)	2·8 (0·6–13·1)
No academic qualifications†	1·3 (1·0–1·5)‡	1·2 (0·9–1·3)	2·3 (0·9–6·0)
Early hospital admissions	1·2 (1·1–1·4)	0·9 (0·6–1·3)	1·2 (0·8–1·7)
Child guidance†	0·7 (0·1–5·0)	2·7 (0·4–19·5)	7·4 (1·0–58·1)
Parental mental illness	0·8 (0·5–1·5)	0·7 (0·2–2·3)	1·3 (0·3–6·2)
Parental death	1·5 (0·7–3·1)	0·6 (0·1–4·4)	. .
Parental disability†	1·2 (0·8–2·0)	1·9 (0·9–4·1)	2·5 (0·7–9·4)

*With psychiatrists' certainty rating of 50%.
†Evidence of shared risk factors between causes of death; selected for inclusion in multivariate model for (sub)intentional death risk. ‡95% CI did not bracket 1; not clear because of rounding. §Graded from high to low.

Table 1: **Developmental and background variables and risk of death during follow-up**

history of child psychiatric treatment, and chronic disability in either or both parents were also suicide risk factors, although the 95% CI bracketed 1. Analysis of only those eight deaths rated by psychiatrists as suicide with 76% confidence or more and analysis of only the eight cases with suicide verdicts gave similar results with two exceptions: male sex (1·4 [1·0–2·0]) and teacher-rated aggression (1·4 [0·9–2·0]) were risk factors for coroner-certified suicide but not for deaths rated as suicides (≥76%) by the psychiatrists (0·6 [0·1–2·5] and 0·8 [0·4–1·8]), respectively. Compared with coroners, psychiatrists felt less confident about one man who died by drowning and one man who was stabbed but more confident about two women who died by self-intoxication.

Developmental variables (measurement age)	Unadjusted for background variables*		Adjusted for background variables†	
	Men	Women	Men	Women
Emotional instability (13)‡	1·3 (0·9–1·8)	1·9 (1·2–2·9)	1·3 (1·0–1·7)	1·4 (1·0–1·9)
Low anxiety (15)§	1·7 (1·3–2·5)	. .	1·7 (1·3–2·5)	. .
Conduct problems (15)§	. .	1·2 (1·0–1·6)	. .	1·4 (1·0–2·0)
Poor physical development (11)	. .	1·3 (1·1–1·6)	. .	1·0 (0·8–1·3)
Enuresis (4)	1·4 (1·1–1·7)	. .	1·4 (1·2–1·7)	. .

*Likelihood ratio test compared with full model (containing aggression as well) for men, p=0·406; for women p=0·451.
†Parental social class, chronic disability, academic achievement, child psychiatric treatment (en bloc).
‡Self-rated. §Teacher rated.

Table 2: **Independence of risk factors for (sub)intentional self-destruction**

Suicide and accidental death—With the exception of adolescent tics, all the risk factors for suicide were also associated with an increased risk of accidental death; however, the link was invariably stronger with suicide.

Premature death of any cause—Of the risk factors common to suicide and accidental death, poor adolescent physical development, conduct problems, lower parental social class, and poor academic achievement were also associated with increased risk of natural death, but associations were invariably weaker than with accidental death and suicide. Best estimates of the association of natural death with teacher-rated aggression, enuresis, and parental disability also indicated increased risk but the 95% CI bracketed 1.

Natural and accidental death but not suicide—Delayed speech development and low intelligence were risk factors for accidental, and, less clearly, premature natural death, but not suicide.

Premature natural death only—A history of long hospital stays during childhood increased risk of natural but not unnatural death; parental death also increased the risk of natural death, though the 95% CI bracketed 1.

Independence of risk factors for (sub)intentional self-destruction—Since the association between low anxiety and (sub)intentional self-destruction (ie, premature death weighted for imputed suicidal intention) differed by sex (likelihood ratio test for interaction p=0·045), separate models were specified for men and women (table 2). With developmental variables only, the best model for men contained observed low anxiety, self-rated emotional instability, and enuresis as independent risk factors. Adjustment for background variables did not alter this pattern. Independent developmental risk factors in the model for women were poor adolescent physical development, conduct problems, and self-related emotional instability. After adjustment for background variables, poor physical development was no longer associated with increased risk. The strongest independent background risk factor was lower parental social class for men (2·0 [1·0–4·3]) and parental disability for women (3·1 [1·3–7·7]). When these models were run unweighted for psychiatrists' ratings of suicidal intention, enuresis remained the only significant developmental risk factor for male premature death (1·2 [1·1–1·5]).

Missing data

Among the developmental and background variables, respectively, the highest proportions of missing scores were 18·7% (teacher-rated aggression) and 21·6% (parental disability). Proportions of missing scores were similar for participants who died and those who survived (smallest p value 0·238 for academic achievement). Male sex (1·3 [1·1–1·4]), parental death (1·5 [1·2–2·1]), adolescent conduct problems (1·1 [1·0–1·2]), low extraversion (0·9 [0·8–1·0]), and poor academic performance (1·2 [1·1–1·3]) were risk factors for loss to follow-up after the 16th birthday. Analysis of the risk of death associated with these variables in the dataset as it had been at members' 16th birthday (n=4891), under the assumption that none of those lost to follow-up had died, resulted in slight adjustments of relative risks but left the patterns unchanged (risk estimates for natural, accidental, and suicidal death: male *vs* female 1·4, 1·3, 1·1; conduct problems 1·2, 1·3, 1·7; extraversion 1·1, 1·0, 1·4;

academic underachievement 1·2, 1·2, 2·1; parental death 1·3, 0·5, not relevant).

Discussion

Childhood and adolescent problems, such as nocturnal enuresis, poor physical development, aggression, conduct problems, low anxiety, and emotional instability, were associated with premature mortality in this study of a general-population birth cohort. The associations were weakest for death from natural causes, intermediate for accidental death, and strongest for suicide. This pattern supports the hypothesis of aetiological continuity between suicide and other causes of premature death.

Competing-risks analyses inevitably assume independence between outcomes;[18] here, individuals who died of one cause were censored (ie, classified as at average risk) for the other outcomes. For risk factors for which the strength of association with mortality rose steadily across death categories (ie, likely generic risk factors for subintentional or intentional self-destruction), this assumption will have led to underestimated risks for all outcomes; individuals who experienced one outcome would also have been at more than average risk for the others, had they survived to experience them. This circumstance may explain why children with low anxiety seemed to be protected against natural death; if most of the high-risk children had died of unnatural causes because of greater impulsivity,[20] any increased risk of natural death would be masked. A similar mechanism could explain why self-reported emotional instability was not a risk factor for premature natural death; individuals at risk may have died of competing causes. However, since this bias affects all outcomes, it cannot explain the observed patterns of increasing strength of associations across death categories.

The finding of increased risk of suicide and related causes of death associated with adolescent conduct problems and aggression accords with reported associations of conduct disorder with impaired physical health,[21] substance use,[11] antisocial personality,[11,12] completed[22] and attempted suicide,[12] and accidental death.[7] Low anxiety levels, in conduct-disordered children, are associated with higher aggression and poor prognosis.[20] Childhood enuresis shows an association with childhood psychiatric illness, particularly with conduct disorders.[20,23] This association may explain why the pattern of links with premature death of this childhood problem reflected that of behavioural variables associated with conduct disorder.

Coroners record a suicide verdict only if there is clear evidence of intent. Clinicians are more prepared to balance probabilities,[24] which may lead to discrepancies when suicide methods such as self-poisoning are used.[25] Such discrepancy was evident in our study, but agreement between raters on cause of death was still good. Compared with more violent methods, self-poisoning is favoured by women more than men,[25] and is less strongly associated with overt aggression.[26] This association explains why aggression and male sex were weaker risk factors for the psychiatrists' high-confidence series (including two self-intoxications) than for the suicide-verdict group (including one stabbing and one drowning instead).

Some risk factors for premature death—including low parental social class, adolescent conduct problems, and poor academic performance—were also risk factors for loss to follow-up. Bias could have resulted if these risk factors were not also risk factors for premature death among the group lost to follow-up. Analyses with the extreme assumption that none of the lost members had died showed that such bias cannot explain the reported patterns.

Consistent with our aim of identifying independent developmental risk factors for suicide and aetiologically linked mortality, we applied, in the multivariate analysis, weights reflecting imputed degrees of suicidal intent. People who died of natural causes and those who survived were classified as having the lowest-scoring unnatural death. This conservative approach was taken so as to avoid artificial attribution of higher degrees of self-destruction to victims of natural death than to survivors. The inclusion in the multivariate model of only those variables for which there had been evidence of aetiological continuity between competing causes of death raises its relevance for the continuum of self-destructive behaviour. We should emphasise that relative risks across different age-ranges were not modelled, so we cannot comment on high-risk periods. Runeson and Rich[27] have suggested that conduct disorder may be more relevant in young people who commit suicide and emotional instability in older suicides. Our investigation cannot throw any light on this difference; suitably designed case-control studies may be needed to examine age effects.

Emotional instability, a precursor of depressive disorder,[12] independently raised the risk of suicide and aetiologically linked causes of death in both men and women. By contrast, enuresis and low anxiety were specific for men, and conduct problems for women. Previous reports disagree about whether the relative contributions of adolescent emotional and conduct disorders to future problems differ between girls and boys. Some studies suggest that, in terms of future suicide, conduct disorder is more relevant in boys and emotional disorder in girls,[28] but others indicate that conduct problems have a worse prognosis in girls than in boys.[29] We cannot exclude the possibility that teachers rate disruptive behaviour as low anxiety in boys, and as conduct problems in girls.[20] Poor physical development and low weight gain are known risk factors for future suicide, but how they relate to background variables, such as low social class, is unclear.[30] In this study, the link between poor physical development and female self-destruction was attributable to background parental and socioeconomic variables.

This study adds to our understanding of the aetiology of suicide and related causes of death. However, its implications in terms of detection of individuals at high risk of premature mortality are limited. Given the low frequency of these outcomes, the variables examined effectively identify those who will not die but do not identify those who will die. The problem of prediction of a rare outcome is well known in suicide research.

Our study supports the existence of at least two separate risk domains for self-destructive behaviours, the first linked with emotional instability and the second with conduct problems and childhood enuresis. Individuals exposed to both, such as conduct-disordered depressive children, or depressed adults with substance use or antisocial personality traits, are at the highest risk of self-

destruction.[27] There is evidence of aetiological continuity between premature causes of death, which, in this study, applied in particular to risk factors from the conduct disorder/aggression domain, and was less clear for emotional instability. The observation that suicide shares some of its main aetiological factors with alternative causes of death indicates that the base rate of premature death other than suicide is an important variable for suicide research and prevention. This idea has not yet received serious attention. Our study extends the scope of psychiatry's concerns with premature mortality from a narrow focus on confirmed suicide to the prevention of premature death of any cause.

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