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ORIGINAL ARTICLE

Prenatal and childhood antecedents of suicide: 50-year follow-up of the 1958 British Birth Cohort Study

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Background. We aimed to elucidate early antecedents of suicide including possible mediation by early child development.

Method. Using the 1958 birth cohort, based on British births in March 1958, individuals were followed up to adulthood. We used data collected at birth and at age 7 years from various informants. Suicides occurring up to 31 May 2009 were identified from linked national death certificates. Multivariable Cox proportional hazard models were used to investigate risk factors.

Results. Altogether 12 399 participants (n=44 suicides) had complete data. The strongest prenatal risk factors for suicide were: birth order, with risk increasing in later-born children [p_{trend}=0.063, adjusted hazard ratio (HR)], e.g. for fourth- or later-born children [HR=2.27, 95% confidence interval (CI) 0.90–5.75]; young maternal age (HR=1.18, 95% CI 0.34–4.13 for ⩽19 years and HR=0.41, 95% CI 0.19–0.91 for >29 years, p_{trend}=0.034); and low (<2.5 kg) birth weight (HR=2.48, 95% CI 1.03–5.95). The strongest risk factors at 7 years were externalizing problems in males (HR=2.96, 95% CI 1.03–8.47, p_{trend}=0.050) and number of emotional adversities (i.e. parental death, neglected appearance, domestic tension, institutional care, contact with social services, parental divorce/separation and bullying) for which there was a graded association with risk of suicide (p_{trend}=0.033); the highest (HR=3.12, 95% CI 1.01–9.62) was for persons with three or more adversities.

Conclusions. Risk factors recorded at birth and at 7 years may influence an individual's long-term risk of suicide, suggesting that trajectories leading to suicide have roots in early life. Some factors are amenable to intervention, but for others a better understanding of causal mechanisms may provide new insights for intervention to reduce suicide risk.

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Key words: Childhood, early life, life-course epidemiology, longitudinal, risk factors, suicide.

Introduction

Every year an estimated 1 million people die by suicide, with one suicide every 40 s around the world (Hawton & van Heeringen, 2009). It is one of the 10 commonest causes of death in young people and hence a key contributor to potential years of life lost (Levi *et al.* 2003). Rather than being the result of a single underlying disease process, suicide risk is influenced by a range of factors occurring at different stages of life (Gunnell & Lewis, 2005). One of the common proximal contributors is psychiatric disorder, especially depression and substance misuse (Cavanagh *et al.* 2003), but other factors, including those from early life, are also thought to be involved (Gunnell & Lewis, 2005).

A standard approach to investigate the causes of suicide is the psychological autopsy (interviews with friends/family/colleagues/carers associated with the deceased) which has been informative about the psychological and contextual circumstances near to suicide (Gould *et al.* 1996; Hawton *et al.* 1998; Foster *et al.* 1999; Cheng *et al.* 2000; Conner *et al.* 2011). However, the role of early life factors on suicide mortality in adulthood has been poorly documented, although available psychological autopsy studies identify severe adverse life events, starting at a very young age, amongst those who die by suicide (Séguin *et al.* 2007, 2011). Of note, psychological autopsy studies are based on the accounts by others of events in the distant past of the individual who has died from suicide and so are prone to recall bias.

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Few prospective studies are of sufficient size or have sufficiently detailed data to investigate early life influences on suicide mortality. The Finnish 1981 Birth Study ($n \sim 5300$) found that most males (but not females) who died by suicide ($n=13$) and/or made serious suicide attempts requiring hospital admission ($n=17$) between 16 and 24 years had behavioural problems by age 8 years (Sourander *et al.* 2009). Prospective and record linkage studies from various countries have reported associations of perinatal circumstances, such as lower birth weight, teenage motherhood and multiparity, with suicide (Mittendorfer-Rutz *et al.* 2004; Riordan *et al.* 2006, 2012) but not all findings are consistent (Osler *et al.* 2008; Gravseth *et al.* 2010). Furthermore, most studies have focused on risk factors identified at a single point in the life course, rather than over the period of early development.

The prospectively recorded data on members of the 1958 British Birth Cohort provide a unique opportunity to examine associations of early life factors, including prenatal circumstances, many aspects of development and emotional adversities by age 7 years, with suicide mortality, in a nationwide population followed up from birth to age 50 years. This study aimed to elucidate early life antecedents of suicide, including the possible mediating role of early child development.

Method

Study sample

The 1958 Birth Cohort is a prospective study of 98% of births in England, Scotland and Wales during 1 week in March 1958 ($n=17\,638$) (Power & Elliott, 2006). We used information collected at the birth survey and subsequent data collection when participants were aged 7 years. Deaths up to 31 May 2009 were ascertained through death certificates (the cohort is flagged in the National Health Service Central Register, NHSCR) or notification to the study team. The NHSCR is not notified of deaths of emigrants. Emigration dates were not available; hence the 1168 cohort members who had emigrated permanently from Britain were excluded from our study ($n=16\,470$).

Mortality

In keeping with the Office for National Statistics (Brock & Griffiths, 2003), suicides were identified from International Classification of Diseases, ninth revision (ICD-9) codes E950–59 (suicide) and E980–89 (undetermined intent) or tenth revision (ICD-10) codes X60–84 (suicide) and Y10–34 (undetermined intent). We have excluded seven pending verdicts (ICD-9 code 988.88; ICD-10 code Y33.9). Combining suicide and undetermined intent deaths will capture most suicides, although a few may be missed especially in more recent years (Gunnell *et al.* 2013).

Early risk factors

Risk factors were chosen based on previous findings in the literature and theoretical considerations, using information obtained at birth and age 7 years from medical practitioners, mothers, teachers and health visitors.

Prenatal circumstances

Birth weight, recorded by the medical doctor at birth, was categorized as low (<2.5 kg) or normal ($\geqslant$2.5 kg). Gestational age was estimated from the date of the mother's last menstrual period. Maternal smoking after the fourth month of pregnancy (non-smoker: <1 or smoker: $\geqslant$1 cigarette/day) was reported shortly after birth. Mother's age at their last birthday was categorized into three groups: $\leqslant$19, 20–29 or >29 years. The child's birth order, reported by mothers when their child was 7 years (including all live and still births and deaths by 7 years) was coded as $\leqslant$1, 2, 3 or $\geqslant$4.

Developmental factors

Bladder control

Mothers reported whether their child was dry (no/yes) during the day between 3 and 7 years or the night between 5 and 7 years.

School tests

At 7 years, children took age-appropriate tests at school for mathematics and reading (Jefferis *et al.* 2002). Arithmetic comprised 10 problems with graded levels of difficulty; for poor readers teachers read out items. Reading skills were measured by the Southgate test requiring an appropriate word to be selected corresponding to a picture. Test scores were standardized for age at testing and grouped into quintiles.

Behaviour problems

Childhood behaviour was assessed by teachers using the Bristol Social Adjustment Guide (BSAG) (Stott, 1969) and by mothers using the Rutter Behaviour Scale (Elander & Rutter, 1996) at 7 years. The BSAG consists of 146 behaviour items assessing 12 syndromes, grouped into internalizing (items such as miserable, and fearful) and externalizing (e.g. resentful/aggressive, and bullies) scores; participants had a score of 1 if an item applied and 0 if it did not apply. The Rutter Scale consists of 14 behaviour items, three

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of which were used to derive an internalizing score (e.g. worries, being miserable/tearful or solitary/withdrawn) and four for an externalizing score (e.g. destructive, irritable, disobedience and fighting); participants had a score of 2 if an item applied 'frequently', 1 for 'sometimes' and 0 for 'never'. The BSAG and Rutter scales demonstrate adequate reliability, sensitivity and external validity in epidemiological surveys (Clark *et al.* 2007). As in previous studies (Clark *et al.* 2007), scores approximating the top 13% were used to define a problem, the lowest 50% were not problem behaviour, and the remainder were intermediate.

Socio-economic adversity

Father's socio-economic position was obtained from mother's report of their husband's occupation soon after the child's birth (or if missing at 7 years). Occupations were categorized according to the 1951 Registrar General's Classification into two categories: non-manual (I/II/IIINM) and manual (IIIM/IV/V). The presence or absence of basic amenities, including a bathroom, indoor lavatory and hot water, was reported by mothers when their child was 7 years.

Emotional adversity

After the 7 years interview with parents, health visitors recorded whether the family was having difficulties because of father's or mother's death, divorce/separation, or domestic tension (no/yes). Health visitors also reported whether the child had had contact with social services and mothers reported whether their child had ever resided in institutional (local authority or voluntary) care. Appearance of neglect was ascertained from teacher's (BSAG) report that the 'appearance of child' was scruffy or dirty at 7 years. Mothers reported (Rutter scale) whether their child had never/sometimes/frequently been bullied by peers. We created a cumulative emotional adversity score by counting the reports of parental death, neglected appearance, domestic tension, institutional care, contact with social services, parental divorce or separation, and frequent bullying. Scores ranged from 0 to 5 and were categorized as 0, 1, 2 or $\geqslant 3$ adverse emotional experiences.

Statistical analyses

Cox proportional hazard models, implemented in SPSS version 19 (IBM, USA), were used to investigate associations of prenatal and childhood risk factors with suicide deaths occurring up to 31 May 2009. Observations were censored: (1) on the date of death from causes other than suicide; or (2) 31 May 2009 if participants were still alive. In a first stage of analysis, we estimated hazard ratios (HRs) and 95% confidence intervals (95% CIs) in univariable analysis based on the maximum number of participants available for each variable. We tested whether there were differences in associations by sex by including an interaction term between sex and the relevant risk factor (categorical variables were treated continuously). In a second stage, we performed multivariable analysis to assess whether prenatal and postnatal factors were associated independently with suicide risk. Specifically, multivariable analysis was used to indicate whether early developmental markers, such as cognitive or emotional development, mediated any associations between prenatal factors and suicide risk, or whether associations of early development with later suicide could be explained by factors occurring previously, i.e. during prenatal life. For multivariable analyses, we selected risk factors with $p \leqslant 0.20$ in univariable analyses. Because the sample available for multivariable analysis (n=12 399) was reduced compared with the maximum sample for univariable analysis (n range=16 242–13 446), we repeated univariable analysis in the reduced sample of 12 399 to check for potential bias associated with missing data. Finally, we estimated the population attributable risk fraction (PAF), i.e. the proportion of suicides in our study that could be prevented if exposure to a specific risk factor had been abolished. PAFs were calculated, assuming that associations were causal, from the multivariable model with full adjustment as follows: proportion exposed (HR – 1)/1 + proportion exposed (HR – 1).

Results

Incidence of suicide in the 1958 British Birth Cohort

Of 16 470 participants in the birth survey in 1958 and who had not emigrated permanently, 1475 had died by 31 May 2009; of these, 51 (44 males, seven females) were suicides (including 13 of undetermined intent). The median age of suicide for males was 40 years (range 18–49 years); for females the median age was 39 years (range 21–49 years). Methods of suicide are shown in Table 1.

Risk factors for suicide in univariable analysis

The strongest associations with prenatal factors were seen for birth weight and maternal age (Table 2); for developmental risk factors measured at age 7 years, the key factors were: being wet during the day after age 3 years, and externalizing behaviours (Table 3); and for indicators of adversity were: manual social class background, parental death, neglected

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Table 1. *Methods of suicide (n=51) in the 1958 British Birth Cohort*

Main ICD categories	ICD codes		Males, *n* (%)	Females, *n* (%)	Total, *n* (%)
	ICD-9	ICD-10			
Poisoning by solid or liquid substances	E950; E980	X60–X65, X68–X69, Y10–Y15, Y18–Y19	8 (18.2)	1 (14.3)	9 (17.6)
Other poisoning (e.g. gases in domestic use, other)	E951–E952, E981–E982	X66–X67, Y16–Y17	9 (20.5)	1 (14.3)	10 (19.6)
Hanging, strangulation and suffocation	E953, E983	X70, Y20	20 (45.5)	2 (28.6)	22 (43.1)
Drowning and submersion	E954, E984	X71, Y21	2 (4.5)	0 (0)	2 (3.9)
Firearms, air guns, explosives	E955, E985	X72–X75, Y22–Y25	0 (0)	0 (0)	0 (0)
Jumping/falling from high places	E957, E987	X80, Y30	0 (0)	2 (28.6)	2 (3.9)
Other injury, including sharp object[a]	E956–E959, E986–E989	X76–X79, X81–X84, Y26–Y29, Y31–Y34	5 (11.4)	1 (14.3)	6 (11.8)
Total[b]			44 (86.3)	7 (13.7)	51 (100.0)

ICD, International Classification of Diseases.
[a] We excluded seven deaths coded 988.88 in ICD-9 and Y33.9 in ICD-10.
[b] Suicide/self-inflicted injury (*n*=38) and undetermined intent (*n*=13) were combined.

Table 2. *Univariable HRs for associations of prenatal factors recorded at birth with suicide*[a]

	Number	HR (95% CI) adjusted for sex	p_{trend}	Interaction with sex: *p*
Neonatal factors				
Low birth weight				0.928
Normal: ⩾2.5 kg	43/14 423	Ref.		
Yes: <2.5 kg	6/1238	2.47 (1.05–5.81)*		
Missing	2/809			
Smoking during pregnancy				0.689
No	33/10 607	Ref.		
Yes	18/5432	1.09 (0.61–1.93)		
Missing	0/431			
Maternal factors				
Child's birth order			0.133	0.474
1	14/5056	Ref.		
2	13/4164	1.11 (0.52–2.36)		
3	10/2101	1.72 (0.77–3.88)		
⩾4	10/2199	1.66 (0.74–3.73)		
Missing	4/2950			
Mother's age at child's birth			0.010	0.456
⩽19 years	5/921	1.51 (0.59–3.83)		
20–29 years	37/9839	Ref.		
>29 years	9/5482	0.44 (0.21–0.92)*		
Missing	0/228			

HR, Hazard ratio; CI, confidence interval; Ref., reference.
[a] Based on all available data with 51 suicides.
* $p<0.05$.

appearance, domestic tension, institutional care, contact with social services, bullying and the overall number of emotional adversities (Table 4). Suicide risk was five times higher (HR=5.27, 95% CI 1.85–14.99) amongst the 283 participants with ⩾3 adversities (*n*=4 or 9% of all suicides) than those with none.

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Table 3. *Univariable HRs for associations of developmental factors recorded at 7 years with suicide*[a]

	Number	HR (95% CI) adjusted for sex	p_{trend}	Interaction with sex: p
Developmental milestone				
Dry at night after age 5 years				0.087[c]
Yes	41/12 002	Ref.		
No	6/1472	1.12 (0.48–2.64)		
Don't know[b]	0/26			
Missing	4/2970			
Dry during day after age 3 years				0.079[c]
Yes	42/12 884	Ref.		
No	5/573	2.72 (1.08–6.88)*		
Don't know[b]	0/42			
Missing	4/2971			
Cognitive				
Reading ability, quintiles			0.867	0.577
1st	14/2815	1.13 (0.50–2.55)		
2nd	7/2628	0.66 (0.25–1.73)		
3rd	11/2916	1.00 (0.42–2.36)		
4th	7/2454	0.81 (0.31–2.12)		
5th	10/3011	Ref.		
Missing	2/2646			
Mathematics ability, quintiles			0.940	0.811
1st	7/2597	0.86 (0.32–2.31)		
2nd	10/2496	1.26 (0.51–3.10)		
3rd	15/3798	1.19 (0.52–2.72)		
4th	8/2291	1.08 (0.42–2.79)		
5th	9/2610	Ref.		
Missing	2/2678			
Behaviour, teacher assessment				
Internalizing behaviour			0.057	0.698
No problem	19/7432	Ref.		
Intermediate	18/4414	1.39 (0.73–2.66)		
Problem	12/1972	2.02 (0.98–4.17)		
Missing	2/2652			
Externalizing behaviour			0.013	0.241
No problem	11/6110	Ref.		
Intermediate	27/5921	2.23 (1.10–4.49)*		
Problem	11/1786	2.67 (1.15–6.18)*		
Missing	2/2653			
Behaviour, mother assessment				
Internalizing behaviour			0.851	0.341
No problem	19/5508	Ref.		
Intermediate	22/6331	1.02 (0.55–1.88)		
Problem	6/1670	1.11 (0.44–2.77)		
Missing	4/2961			
Externalizing behaviour			0.012	0.057[d]
No problem	9/5323	Ref.		
Intermediate	24/6047	1.91 (0.89–4.12)		
Problem	14/2138	2.89 (1.24–6.71)*		
Missing	4/2962			

HR, Hazard ratio; CI, confidence interval; Ref., reference; N.A., not applicable (there was no event in females).

[a] Based on all available data with 51 suicides.

[b] The 'don't know' category was not associated with suicide mortality and was combined with 'no'.

[c] The elevated suicide risk associated with not being dry at night and day was seen in females (HRs=4.58, 95% CI 0.84–25.02 and 11.53, 95% CI 2.11–62.94, respectively), but not in males (HRs=0.81, 95% CI 0.29–2.67 and 1.80, 95% CI 0.56–5.84, respectively). However, those analyses were based on a small number of females (n=2) with both exposure and event.

[d] The elevated suicide risk associated with externalizing behaviour recorded by mothers was seen in males (HRs=2.88, 95% CI 1.09–7.61 for intermediate and 4.59, 95% CI 1.65–12.74 for problems, p_{trend}=0.002), but not in females (HRs=0.58, 95% CI 0.11–3.18 for intermediate and N.A. for problems, p_{trend}=0.281).

* $p<0.05$.

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Risk factors for suicide in multivariable analysis

The 14 risk factors ($p \leqslant 0.20$) were included in multivariable analysis ($n=12\,399$ participants and 44 suicides; Table 5). Compared with suicides for which data were complete for all 14 risk factors ($n=44$), those with missing information (one female and six males) had died at a younger age (31 *v.* 38 years, $p=0.073$). However, estimates for suicide risk associated with prenatal and postnatal factors from univariable analyses were broadly comparable in both the maximum and complete case (multivariable) samples (Tables 2–4 *v.* Table 5). Table 5 shows that associations for separate prenatal factors were little changed in multivariable models controlling for other prenatal factors and there was little evidence of mediation by early childhood adversity or development measured at age 7 years. In multivariable analysis, low birth weight (<2.5 kg) was associated with a 2.48 (95% CI 1.03–5.95, PAF=8%) times higher suicide risk. In additional analysis, based on the subset ($n=10\,875$ including 38 suicides) of participants with records of gestational age, the HR for low birth weight was 2.25 (95% CI 0.80–6.35) and this was somewhat attenuated (HR=1.86, 95% CI 0.58–5.98) after controlling for gestational age. There was a trend of higher risk of suicide mortality with increasing birth order ($p_{trend}=0.063$), with the highest risk for fourth born or later births (HR=2.27, 95% CI 0.90–5.75, PAF=17%). For maternal age, a trend ($p_{trend}=0.034$) was observed from the highest suicide risk for younger mothers to the lowest risk for older mothers (HRs=1.18 for $\leqslant$19 years group to 0.41 for >29 years *v.* 20–29 years; PAF=22% for maternal age categorized as below and above 23 years, i.e. the 25th percentile).

For childhood adversity and development markers, there was a general observation of risk attenuation in multivariable analysis, suggesting that associations were due in part to prior or contemporaneous factors. For example, HRs for internalizing and externalizing behaviours reduced after controlling for prenatal and other early childhood factors. For externalizing behaviours rated by mothers an elevated suicide risk was seen in males, but not females (p for interaction with sex=0.060). In univariable analyses in the reduced sample of 12399 HRs were 2.65 (95% CI 0.99–7.05) and 4.31 (95% CI 1.54–12.09) for intermediate and problem externalizing behaviors in males (online Supplementary Table S1) and 0.58 (95% CI 0.11–3.18) for intermediate level externalizing behaviour in females; there were too few suicides to assess associations with problem behaviour in females). Although the risk for males was considerably attenuated in the multivariable model, the risk of suicide increased with severity of behaviour ($p_{trend}=0.050$) to almost threefold for those with problem behaviour (HR=2.96, 95% CI 1.03–8.47, PAF=28%); this finding held when teachers' assessments were excluded from the model (HR=3.19, 95% CI 1.12–9.12). Separate items on the externalizing scale showed a graded association ($p_{trend}<0.001$) for suicide risk with the frequency of property destruction (for 'frequently' HR=4.68, 95% CI 1.92–11.41) and for 'frequently fighting other children' HR=3.90 (95% CI 1.13–13.48), but no association was observed for 'irritable' and 'disobedient'. Similarly, the elevated suicide risk associated with number of adverse emotional experiences attenuated in multivariable analysis, but a trend remained ($p_{trend}=0.033$), with the highest HR (3.12, 95% CI 1.01–9.62) for persons with $\geqslant$3 *versus* no adverse experiences (Table 5). The population prevalence of having at least one adverse emotional experience by 7 years was 18.7% (12.9% had 1, 3.7% had 2, and 2.1% had $\geqslant$3); PAF for $\geqslant$1 emotional adversity was 13%. Online Supplementary Table S2 presents univariable and multivariable analyses for each emotional adversity; parental death was associated with a 4.34 (95% CI 1.30–14.47) times higher suicide risk.

Discussion

Suicide is often considered to be caused by mental disorder and adverse events such as job loss and relationship difficulties around the time of death. Our analysis reveals associations with a series of risk factors recorded in the first 7 years of life, suggesting that trajectories leading to suicide in adulthood have roots in early life. The strongest associations were seen with low birth weight, younger maternal age, higher birth order, higher number of emotional adversities (particularly parental death and bullying by peers) and externalizing problems in males. Remarkably, some associations were undiminished in simultaneous analysis of prenatal and early childhood factors. Of particular note is our finding that none of the associations with prenatal factors was weakened greatly when we controlled for several factors measured at 7 years, indicating that they operate through other pathways. The increasing suicide risk with higher levels of emotional adversity is also notable, suggesting that such adversities influence risk outwith other early life influences. The PAFs varied greatly (8 to 28%) across risk factors; the largest PAF was attributed to externalizing problems in males.

Methodological considerations

Our study population is large and nationally representative of British residents born in 1958, and captures many key aspects of perinatal circumstances,

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Table 4. *Univariable HRs for associations of adversity factors recorded at 7 years with suicide*[a]

	Number	HR (95% CI) adjusted for sex	p_{trend}	Interaction with sex: p
Economic adversity				
Father's social class at birth				N.A.
Non-manual	8/4251	Ref.		
Manual	43/12 052	1.94 (0.91–4.13)		
Missing	0/167			
Lack/sharing amenities				0.877
No	38/10 891	Ref.		
Yes	9/2555	1.01 (0.49–2.09)		
Don't know[b]	0/9			
Missing	4/3015			
Emotional adversity				
Parental death				N.A.
No	41/12 795	Ref.		
Yes	3/211	4.52(1.40–14.59)*		
Don't know[b]	2/524			
Missing	5/2940			
Neglect appearance				0.392
No	44/13 669	Ref.		
Yes	5/596	2.34 (0.93–5.90)		
Missing	2/2205			
Domestic tension				0.065[c]
No	34/10 990	Ref.		
Yes	5/726	1.48 (0.93–2.37)		
Don't know[b]	7/1804			
Missing	5/2950			
Institutional care				N.A.
No	43/13 296	Ref.		
Yes	4/287	4.22 (1.51–11.76)*		
Don't know[b]	0/34			
Missing	4/2853			
Contact with social services				0.713
No	39/11 600	Ref.		
Yes	6/584	1.80 (1.17–2.76)*		
Don't know[b]	2/1364			
Missing	4/2922			
Parents divorce/separation				N.A.
No	39/12 382	Ref.		
Yes	4/537	1.69 (0.60–4.72)		
Don't know[b]	4/604			
Missing	4/2947			
Peer bullying			0.059	0.675
Never	24/8669	Ref.		
Sometimes	16/3940	1.36 (0.72–2.56)		
Frequently	6/721	2.84 (1.16–6.96)*		
Don't know[b]	1/208			
Missing	4/2932			
No. of emotional adverse experiences			$\leqslant$0.001	0.490
None	29/10 942	Ref.		
1	9/1741	1.94 (0.92–4.10)		
2	4/500	2.86 (1.00–8.13)*		
$\geqslant$3	4/283	5.27 (1.85–14.99)*		
Missing	5/3004			

HR, Hazard ratio; CI, confidence interval, Ref., reference; N.A., not applicable (there was no event in females).

[a] Based on all available data with 51 suicides.

[b] The 'Don't know' category was not associated with suicide mortality and was combined with 'no'.

[c] The elevated suicide risk associated with domestic tension was seen in females (HR=3.29, 95% CI 1.35–8.06), but not in males (HR=1.20, 95% CI 0.66–2.16). However, this analysis was based on a small number of females (n=2) with both exposure and event.

* $p<0.05$.

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Table 5. *Univariable and multivariable HRs of prenatal and postnatal factors at 7 years with suicide*[a]

		Univariable (n=12 399)		Multivariable (n=12 399)		
	Number	HR (95% CI) adjusted for sex	p_{trend}	HR (95% CI) fully adjusted	p_{trend}	Interaction with sex: p
Prenatal factors						
Low birth weight						0.951
Normal: ⩾2.5 kg	38/11 675	Ref.		Ref.		
Yes: <2.5 kg	6/724	2.94 (1.24–6.96)*		2.48 (1.03–5.95)*		
Child's birth order			0.157		0.063	0.433
1	13/4625	Ref.		Ref.		
2	13/3820	1.19 (0.55–2.56)		1.38 (0.62–3.06)		
3	8/1915	1.49 (0.62–3.60)		1.84 (0.73–4.68)		
⩾4	10/2039	1.75 (0.77–3.98)		2.27 (0.90–5.75)		0.532
Mother's age at child's birth			0.071		0.034	
⩽19 years	3/654	1.12 (0.34–3.66)		1.18 (0.34–4.13)		
20–29 years	32/7554	Ref.		Ref.		
>29 years	9/4191	0.51 (0.24–1.06)		0.41 (0.19–0.91)*		
Early childhood (⩽7 years) factors						
Dry during day after age 3 years						0.099[b]
Yes	39/11 878	Ref.		Ref.		
No	5/521	2.99 (1.18–7.58)*		2.12 (0.82–5.50)		
Internalizing behaviour, teacher			0.129		0.742	0.597
No problem	18/6718	Ref.		Ref.		
Intermediate	16/3926	1.34 (0.68–2.63)		1.03 (0.51–2.07)		
Problem	10/1755	1.81 (0.83–3.92)		1.14 (0.50–2.58)		
Externalizing behaviour, teacher			0.026		0.348	0.266
No problem	11/5529	Ref.		Ref.		
Intermediate	23/5307	1.92 (0.94–3.95)		1.53 (0.73–3.21)		
Problem	10/1563	2.52 (1.06–5.94)*		1.51 (0.60–3.80)		
Externalizing behaviour, mother			0.020		0.199	0.060[c]
No problem	9/4907	Ref.		Ref.		
Intermediate	22/5543	1.78 (0.82–3.87)		1.59 (0.73–3.47)		
Problem	13/1949	2.73 (1.16–6.42)*		1.76 (0.73–4.24)		
Social class						N.A.
Non-manual	7/3253	Ref.		Ref.		
Manual	37/9146	1.87 (0.83–4.20)		1.40 (0.62–3.19)		
No. of emotional adverse experiences			⩽0.001		0.033	0.533
0	27/10 081	Ref.		Ref.		
1	9/1612	2.06 (0.97–4.38)		1.53 (0.70–3.34)		
2	4/455	3.11 (1.09–8.89)*		2.21 (0.75–6.54)		
⩾3	4/251	5.85 (2.05–16.72)*		3.12 (1.01–9.62)*		

HR, Hazard ratio; CI, confidence interval, Ref., reference; N.A., not applicable (there was no event in females).

[a] Based on 12 399 cohort members with complete data for multivariable analysis with 44 suicides.

[b] The elevated suicide risk associated with not being dry during the day was seen in females (HR fully adjusted=21.31, 95% CI 3.07–147.52), but not in males (HR fully adjusted=1.43, 95% CI 0.43–4.74). However, this analysis was based on a small number of females (n=2) with both exposure and event.

[c] The elevated suicide risk associated with externalizing behaviour recorded by mothers was seen in males (HRs fully adjusted=2.43, 95% CI 0.91–6.48 for intermediate and 2.96, 95% CI 1.03–8.47 for problems, p_{trend}=0.050), but not in females (HR fully adjusted=0.47, 95% CI 0.80–2.75 for intermediate and N.A. for problems).

* p<0.05.

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family background, and behavioural and emotional development to age 7 years. Furthermore, the availability of birth data and detailed information on cohort members at 7 years allowed us to explore pathways linking birth-related risk factors to later suicide risk. The availability of prospectively recorded assessments from multiple informants, suicide mortality over five decades of life, low attrition rate and nationwide coverage are particular strengths of the study. The main limitation is study power (type II error), particularly when investigating sex differences in associations due to the small number of suicides, given the low incidence of suicide. In addition, type I error may also exist as we performed several comparisons. Owing to the rarity of suicide events, CIs for HRs were wide, particularly in multivariable analyses. Furthermore, the key assumption in the calculation of PAFs is that factors are causally associated with suicide; as our design is observational and so prone to confounding, the PAFs should be interpreted with caution. However, they do nevertheless enable us to quantify the potential public health importance of different risk factors.

There were some missing data; however, associations were replicated in the reduced sample available for multivariable analysis. We had no information on abuse in childhood – this is known to be strongly associated with self-reported suicidal attempts (Dube *et al.* 2001; Brezo *et al.* 2008). To the best of our knowledge, no prospective study has examined associations of abuse and suicide mortality. We have examined the possibility that prenatal and early childhood factors are operating through related pathways, but mediation or moderation through later, i.e. more proximal, factors remains a possibility. The strength of associations reported here for distal risk factors for suicide (HRs varied between 2.3 and 3.0) is similar to that reported in other epidemiological studies for proximal contextual risk factors such as unemployment and divorce/separation in adulthood (Kposowa, 2000; Lundin *et al.* 2012), although mental health disorders preceding suicide remain one of the strongest predictors (Gunnell & Lewis, 2005). Finally, perinatal and childhood circumstances of the 1958 cohort may differ from those of today's generation, which may reduce the generalizability of our findings. However, similar findings reported for more recent cohorts (Mittendorfer-Rutz *et al.* 2008; Sourander *et al.* 2009) suggest that our results remain relevant.

Comparison with other studies

Prenatal factors

Although there is a growing literature on perinatal circumstances and suicide (Mittendorfer-Rutz *et al.* 2004; Riordan *et al.* 2006, 2012), our study was the first, as far as we are aware, to show that associations between perinatal circumstances and suicide were unexplained by a wide range of possible childhood intermediate factors, including emotional adversities and behavioural development by 7 years. HRs reported here for low birth weight, higher birth order and younger motherhood were broadly in agreement with previous studies on perinatal factors and suicide (Mittendorfer-Rutz *et al.* 2004; Riordan *et al.* 2006, 2012). For instance, a Swedish record linkage study of over 700 000 young adults born 1973 to 1980, with 563 suicides, reported multivariable HRs of 2.2 for low birth weight and of 2.3 for teenage mothers (<19 years *v.* 20–29 years) (Mittendorfer-Rutz *et al.* 2004). As reported in previous studies (Mittendorfer-Rutz *et al.* 2004), the association of low birth weight and suicide was little changed after adjustment for gestational age. Some (Riordan *et al.* 2006, 2012) but not all (Mittendorfer-Rutz *et al.* 2004) studies reported elevated suicide risk for higher multiparity or birth order, and as mentioned above, we show that such associations with suicide risk are independent of several childhood influences. It has been suggested that adversity may be linked to long-lasting changes in the expression of genes related to the biological stress response, possibly implicated in the development of mental disorders and suicidal behaviours via epigenetic modification (Turecki *et al.* 2012). Hence, as higher birth order is correlated with decreased quality time with the mother (Jacobs & Moss, 1976), associations between such distal prenatal risk factors (or other childhood adversity) and suicide mortality may operate via epigenetic mechanisms.

Postnatal factors

Our results yield important new insights into the connection of externalizing problems in early childhood with suicide mortality in later life. Males have a higher incidence of both suicide and externalizing problems than females in most countries (Clark *et al.* 2007; Hawton & van Heeringen, 2009). Our findings revealed that externalizing problems at 7 years were associated with three times the risk of completed suicide in males. Externalizing problems in childhood link, in turn, to problems around the time of the suicide, such as impulsive or disruptive behaviours and criminal convictions, that have been identified in both epidemiological (Björkenstam *et al.* 2011) and psychological autopsy studies (Shaffer *et al.* 1996; Cheng *et al.* 2000). A recent Swedish register-based cohort study comprising about 1 million births from 1972 to 1981 showed that suicide rates up to the age of 25–34 years in males (n=1086) and females (n=396) increased with the number of criminal

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convictions, an indicator of externalizing behaviours, between 15 and 19 years, with a stronger association for males [crude incidence rate ratio (IRR)=12.3 for males with five or more convictions] (Björkenstam *et al.* 2011). Associations decreased substantially (IRR =3.0), but were not entirely explained by social background, individual psychiatric history and substance abuse. Our study contributes to this literature in showing strong associations of problem behaviours in those as young as 7 years, as suggested by one epidemiological study combining suicide mortality and attempts (Sourander *et al.* 2009). Associations were strong for items assessing 'destructive behaviour' and 'fighting', but not 'irritability' or 'disobedience', suggesting that suicide is associated with severe disturbance only.

Our findings confirm previous findings from psychological autopsy studies (Séguin *et al.* 2007, 2011) suggesting that, for most individuals, trajectories leading to suicide in adulthood have roots in early life. Indeed, we found a dose–response association between the number of emotional adversities and suicide, with highest suicide risks among those experiencing three or more adverse experiences, independently of other factors examined. In a large US study, retrospective reports of the number of adverse childhood experiences were associated with self-reported suicide attempts from childhood to young adulthood (Dube *et al.* 2001). Our study found that parental death was independently associated with considerably increased suicide risk. We were not able to determine whether parental deaths were due to suicides; hence genetic and other factors could be contributing to this association (Geulayov *et al.* 2012).

However, we detected no association between markers of school performance and subsequent suicide, and this is discrepant with some studies (Gunnell *et al.* 2005, 2011; Gravseth *et al.* 2010), but agrees with others (Neeleman *et al.* 1998; Sourander *et al.* 2009). These inconsistent findings may possibly reflect age differences in measurement, whereby cognitive abilities measured in adolescence or early adulthood (Gunnell *et al.* 2005, 2011; Gravseth *et al.* 2010), but not in early childhood (Neeleman *et al.* 1998; Sourander *et al.* 2009), are associated with suicide mortality.

Mental illness as intermediary factor

Suicide usually occurs in the course of a mental disorder, especially depression with or without co-morbid substance misuse (Cavanagh *et al.* 2003). It is noteworthy that most early life factors associated with suicide mortality in the present study (e.g. low birth weight, high birth order, younger maternal age, emotional adversities) are predictors of depression (Cheung, 2002) or psychiatric admission (Riordan *et al.* 2012) in adulthood. This may suggest that pathways from early life circumstances to suicide mortality in adulthood may involve mental health disorders at later stages of the life-course. Our findings indicate that externalizing problems at 7 years predict suicide mortality around 40 years more strongly than internalizing problems. Previous analysis of the 1958 cohort has shown the opposite in relation to depression, with a somewhat weaker association between externalizing behaviours at 7 years and major depressive disorder at age 45 years [odds ratio (OR)=1.59, 95% CI 0.92–2.74] than for internalizing behaviours (OR= 2.12, 95% CI 1.34–3.36) (Clark *et al.* 2007).

Implications

Risk factors in place around the time of birth and during early childhood may have an influence on suicide mortality. Some of these factors, such as bullying, are amenable to intervention (Mann *et al.* 2005; Hawton *et al.* 2012) but for others a better understanding of causal mechanisms may provide new insights for intervention to reduce suicide risk. Our results suggest that efforts to prevent externalizing problems in males beginning at an early age may translate into a reduction of suicide in adult life, if the relationship is causal. Early interventions to prevent aggression (e.g. family/parent training programmes or nurse home visits) have been proven to be effective (Olds *et al.* 1998; Piquero *et al.* 2009). More generally, the early risk factors identified here for increased risk of suicide mortality are associated with many other adverse outcomes. This suggests that interventions to mitigate these risk factors may have wide-ranging positive effects.

Supplementary material

For supplementary material accompanying this paper visit http://dx.doi.org/10.1017/S003329171300189X.

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Declaration of Interest

None.

References

Björkenstam E, Björkenstam C, Vinnerljung B, Hallqvist J, Ljung R (2011). Juvenile delinquency, social background and suicide–a Swedish national cohort study of 992,881 young adults. *International Journal of Epidemiology* **40**, 1585–1592.

Brezo J, Paris J, Vitaro F, Hébert M, Tremblay RE, Turecki G (2008). Predicting suicide attempts in young adults with histories of childhood abuse. *British Journal of Psychiatry* **193**, 134–139.

Brock A, Griffiths C (2003). Trends in suicide by method in England and Wales, 1979 to 2001. *Health Statistics Quarterly* **20**, 7–17.

Cavanagh JTO, Carson AJ, Sharpe M, Lawrie SM (2003). Psychological autopsy studies of suicide: a systematic review. *Psychological Medicine* **33**, 395–405.

Cheng AT, Chen TH, Chen C-C, Jenkins R (2000). Psychosocial and psychiatric risk factors for suicide: case–control psychological autopsy study. *British Journal of Psychiatry* **177**, 360–365.

Cheung YB (2002). Early origins and adult correlates of psychosomatic distress. *Social Science and Medicine* **55**, 937–948.

Clark C, Rodgers B, Caldwell T, Power C, Stansfeld S (2007). Childhood and adulthood psychological ill health as predictors of midlife affective and anxiety disorders: The 1958 British Birth Cohort. *Archives of General Psychiatry* **64**, 668–678.

Conner KR, Beautrais AL, Brent DA, Conwell Y, Phillips MR, Schneider B (2011). The next generation of psychological autopsy studies. *Suicide and Life-Threatening Behavior* **41**, 594–613.

Dube SR, Anda RF, Felitti VJ, Chapman DP, Williamson DF, Giles WH (2001). Childhood abuse, household dysfunction, and the risk of attempted suicide throughout the life span findings from the Adverse Childhood Experiences Study. *Journal of the American Medical Association* **286**, 3089–3096.

Elander J, Rutter M (1996). Use and development of the Rutter parents' and teachers' scales. *International Journal of Methods in Psychiatric Research* **6**, 63–78.

Foster T, Gillespie K, McClelland R, Patterson C (1999). Risk factors for suicide independent of DSM-III-R Axis I disorder. Case–control psychological autopsy study in Northern Ireland. *British Journal of Psychiatry* **175**, 175–179.

Geulayov G, Gunnell D, Holmen T, Metcalfe C (2012). The association of parental fatal and non-fatal suicidal behaviour with offspring suicidal behaviour and depression: a systematic review and meta-analysis. *Psychological Medicine* **42**, 1567–1580.

Gould MS, Fisher P, Parides M, Flory M, Shaffer D (1996). Psychosocial risk factors of child and adolescent completed suicide. *Archives of General Psychiatry* **53**, 1155–1162.

Gravseth HM, Mehlum L, Bjerkedal T, Kristensen P (2010). Suicide in young Norwegians in a life course perspective: population-based cohort study. *Journal of Epidemiology and Community Health* **64**, 407–412.

Gunnell D, Bennewith O, Simkin S, Cooper J, Klineberg E, Rodway C, Sutton L, Steeg S, Wells C, Hawton K (2013). Time trends in coroners' use of different verdicts for possible suicides and their impact on officially reported incidence of suicide in England: 1990–2005. *Psychological Medicine* **43**, 1415–1422.

Gunnell D, Lewis G (2005). Studying suicide from the life course perspective: implications for prevention. *British Journal of Psychiatry* **187**, 206–208.

Gunnell D, Löfving S, Gustafsson JE, Allebeck P (2011). School performance and risk of suicide in early adulthood: follow-up of two national cohorts of Swedish schoolchildren. *Journal of Affective Disorders* **131**, 104–112.

Gunnell D, Magnusson PKE, Rasmussen F (2005). Low intelligence test scores in 18 year old men and risk of suicide: cohort study. *British Medical Journal* **330**, 167–171.

Hawton K, Appleby L, Platt S, Foster T, Cooper J, Malmberg A, Simkin S (1998). The psychological autopsy approach to studying suicide: a review of methodological issues. *Journal of Affective Disorders* **50**, 269–276.

Hawton K, Saunders KEA, O'Connor RC (2012). Self-harm and suicide in adolescents. *Lancet* **379**, 2373–2382.

Hawton K, van Heeringen K (2009). Suicide. *Lancet* **373**, 1372–1381.

Jacobs BS, Moss HA (1976). Birth order and sex of sibling as determinants of mother–infant interaction. *Child Development* **47**, 315–322.

Jefferis BJMH, Power C, Hertzman C (2002). Birth weight, childhood socioeconomic environment, and cognitive development in the 1958 British birth cohort study. *British Medical Journal* **325**, 305–308.

Kposowa AJ (2000). Marital status and suicide in the National Longitudinal Mortality Study. *Journal of Epidemiology and Community Health* **54**, 254–261.

Levi F, La Vecchia C, Lucchini F, Negri E, Saxena S, Maulik PK, Saraceno B (2003). Trends in mortality from suicide, 1965–99. *Acta Psychiatrica Scandinavica* **108**, 341–349.

Lundin A, Lundberg I, Allebeck P, Hemmingsson T (2012). Unemployment and suicide in the Stockholm population: a register-based study on 771,068 men and women. *Public Health* **126**, 371–377.

Mann J, Apter A, Bertolote J, Beautrais A, Currier D, Haas A, Hegerl U, Lonnqvist J, Malone K, Marusic A, Mehlum L, Patton G, Phillips M, Rutz W, Rihmer Z, Schmidtke A, Shaffer D, Silverman M, Takahashi Y, Varnik A, Wasserman D, Yip P, Hendin H (2005). Suicide

prevention strategies: a systematic review. *Journal of the American Medical Association* **294**, 2064–2074.

Mittendorfer-Rutz E, Rasmussen F, Wasserman D (2004). Restricted fetal growth and adverse maternal psychosocial and socioeconomic conditions as risk factors for suicidal behaviour of offspring: a cohort study. *Lancet* **364**, 1135–1140.

Mittendorfer-Rutz E, Wasserman D, Rasmussen F (2008). Fetal and childhood growth and the risk of violent and non-violent suicide attempts: a cohort study of 318 953 men. *Journal of Epidemiology and Community Health* **62**, 168–173.

Neeleman J, Wessely S, Wadsworth M (1998). Predictors of suicide, accidental death, and premature natural death in a general-population birth cohort. *Lancet* **351**, 93–97.

Olds D, Henderson CR Jr, Cole R, Eckenrode J, Kitzman H, Luckey D, Pettitt L, Sidora K, Morris P, Powers J (1998). Long-term effects of nurse home visitation on children's criminal and antisocial behavior. *Journal of the American Medical Association* **280**, 1238–1244.

Osler M, Nybo Andersen A-M, Nordentoft M (2008). Impaired childhood development and suicidal behaviour in a cohort of Danish men born in 1953. *Journal of Epidemiology and Community Health* **62**, 23–28.

Piquero AR, Farrington DP, Welsh BC, Tremblay R, Jennings WG (2009). Effects of early family/parent training programs on antisocial behavior and delinquency. *Journal of Experimental Criminology* **5**, 83–120.

Power C, Elliott J (2006). Cohort profile: 1958 British birth cohort (National Child Development Study). *International Journal of Epidemiology* **35**, 34–41.

Riordan D, Morris C, Hattie J, Stark C (2012). Family size and perinatal circumstances, as mental health risk factors in a Scottish birth cohort. *Social Psychiatry and Psychiatric Epidemiology* **47**, 975–983.

Riordan DV, Selvaraj S, Stark C, Gilbert JSE (2006). Perinatal circumstances and risk of offspring suicide. *British Journal of Psychiatry* **189**, 502–507.

Séguin M, Lesage A, Turecki G, Bouchard M, Chawky N, Tremblay N, Daigle F, Guy A (2007). Life trajectories and burden of adversity: mapping the developmental profiles of suicide mortality. *Psychological Medicine* **37**, 1575–1583.

Séguin M, Renaud J, Lesage A, Robert M, Turecki G (2011). Youth and young adult suicide: a study of life trajectory. *Journal of Psychiatric Research* **45**, 863–870.

Shaffer D, Gould MS, Fisher P, Trautman P, Moreau D, Kleinman M, Flory M (1996). Psychiatric diagnosis in child and adolescent suicide. *Archives of General Psychiatry* **53**, 339.

Sourander A, Klomek AB, Niemelä S, Haavisto A, Gyllenberg D, Helenius H, Sillanmäki L, Ristkari T, Kumpulainen K, Tamminen T, Moilanen I, Piha J, Almqvist F, Gould MS (2009). Childhood predictors of completed and severe suicide attempts findings from the Finnish 1981 Birth Cohort Study. *Archives of General Psychiatry* **66**, 398–406.

Stott D (1969). *The Social Adjustment of Children*. University of London Press: London.

Turecki G, Ernst C, Jollant F, Labonté B, Mechawar N (2012). The neurodevelopmental origins of suicidal behavior. *Trends in Neurosciences* **35**, 14–23.