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Perinatal risk factors in offenders with severe personality disorder: a population-based investigation

Seena Fazel, **Liliya Bakiyeva**, **Sven Cnattingius**, **Martin Grann**, **Christina M. Hultman**, **Paul Lichtenstein**, and **John R. Geddes**
Department of Psychiatry, University of Oxford, Warneford Hospital, Oxford (Drs Fazel & Bakiyeva, Prof Geddes), Centre for Violence Prevention, Karolinska Institutet, Stockholm, Sweden (Dr Fazel, Prof Grann), Department of Medical Epidemiology and Biostatistics, Karolinska Institutet, Stockholm, Sweden (Profs Hultman & Lichtenstein), and Clinical Epidemiology Unit, Department of Medicine, Karolinska University Hospital Solna, Karolinska Institutet, Stockholm, Sweden (Prof. Cnattingius)

Abstract

Although perinatal factors are associated with the development of several psychiatric disorders, it is unknown whether these factors are linked with personality disorder. Cases of personality disorder were drawn from a national registry of all forensic psychiatric evaluations (n=150). Two control groups were used: 1. A sample of forensic evaluations without any psychiatric disorder (n=97) allowing for a nested case-control investigation; 2: A population-based sample matched by age and gender with no history of psychiatric hospitalization (n=1498). Prematurity (<37 weeks of completed gestation) was significantly associated with a diagnosis of personality disorder, both in the nested and the population-based case-control comparisons with adjusted odds ratios (OR) for this risk factors ranging from 2 to 4. Asphyxia (adjusted OR=2.4, 95% CI: 1.4-4.1) and complicated delivery (adjusted OR=1.5, 1.0-2.1) were associated with personality disorder in the population-based study, and the former remained significant in multivariate models. Overall, perinatal complications were found to be associated with a later diagnosis of personality disorder in this selected sample. As with other psychiatric disorders where such associations have been demonstrated, changes during the perinatal period may lead to abnormal brain development and function.

Keywords

Perinatal risk factors; personality disorder; asphyxia; borderline personality disorder; antisocial personality disorder; nested case-control study

Introduction

Perinatal factors have been shown to increase the risk of the development of several psychiatric disorders with onset in childhood or early adulthood including schizophrenia and other psychotic disorders (Verdoux et al., 1997; Hultman et al., 1999; Cannon et al., 2002; Buka et al., 2008), autism (Hultman et al., 2002; Gardener et al., 2009), attention-deficit/

Correspondence: Dr Seena Fazel, University Department of Psychiatry, Warneford Hospital, Oxford OX3 7JX, UK. seena.fazel@psych.ox.ac.uk.

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Location of work: Centre for Violence Prevention, Karolinska Institutet, Stockholm, Sweden and Department of Psychiatry, University of Oxford, Warneford Hospital, Oxford

hyperactivity symptoms (Hultman et al., 2007), depression (Preti et al., 2000), and anorexia nervosa (Cnattingius et al., 1999). However, little is known about the potential role of perinatal risk factors in the development of personality disorders. Any such associations with perinatal complications may assist in a clearer understanding of the etiology and classification of personality disorders (New et al., 2008).

The limited research to date has demonstrated a possible association of perinatal factors and specific personality disorders. In antisocial personality disorder, the evidence is conflicting. One study of 56 individuals with antisocial personality disorder found no significant relationship with perinatal complications (Buka et al., 1993), while another found clear associations with severe nutritional deficiency in the first and second trimester of pregnancy in a national cohort (Neugebauer et al., 1999). Another study of 66 patients with borderline personality disorder showed higher rates of birth risk factors compared with healthy controls and prematurity in particular (Bandelow et al., 2005). One other report of predominantly cluster B (such as antisocial and borderline) personality disorders found an association with low birth weight when compared to health controls but not individuals with schizophrenia and affective disorders (Dahl & Boerdahl 1993). Little evidence exists for other personality disorders. One study of 260 offenders with personality disorders demonstrated increased rates of perinatal complications in forensic psychiatric patients with schizoid, dependant and avoidant personality disorders compared with other personality disorders (Coid 1999), but as no control group was used, the implications of these associations remains unclear.

In offenders with or without personality disorders, the evidence is also conflicting. Earlier findings of clear associations between obstetric complications and prenatal exposure to maternal smoking with violent crime in adulthood (Raine et al., 1997; Brennan et al., 2002; Pratt et al., 2006) have been subsequently challenged. In particular, the association with maternal smoking appears to be confounded by familial factors (D'Onofrio et al., 2010), and the relationship of criminality with obstetric complications has not been shown to be independent of adverse parenting (Hodgins et al., 2001) or adverse family environments (Arseneault et al., 2002). However, associations with violent outcomes in mentally ill populations may be independent of interactions with early environmental factors (Cannon et al., 2002; Hodgins et al., 2002).

In the present investigation, we report associations between specific obstetric risk factors and risks of personality disorders in a sample of offenders. Comparisons are made using two control groups: a sample of criminal offenders with no mental disorder (a nested case-control study) and a population-based control group. With most of the case-control studies cited above finding significant associations of perinatal complications with personality disorder, we hypothesized that overall there would be an association. However, as previous studies have lacked detailed exposure information and limitations in statistical power have meant that links with specific perinatal complications remain uncertain, we additionally aimed to investigate whether there were any specific perinatal complications. On the basis of previous work in schizophrenia (Cannon et al., 2002), we hypothesized that birth asphyxia would have the strongest associations with PD.

Methods

Linkage of databases

We linked several nationwide population-based registries in Sweden: The National Birth Registry (held at the National Board of Health and Welfare), the Forensic Psychiatric Evaluation register (held at the National Council for Crime Prevention), and The Hospital Discharge Registry (National Board of Health and Welfare). In Sweden, all residents

including immigrants have a unique 10-digit personal identification number that is used in all national registers, thus making the linking of data in these registers possible.

Identification of individuals with personality disorder

Cases of personality disorder were drawn from a national sample of all mentally disordered offenders who were referred and assessed for forensic psychiatric evaluation (FPE) during 1988-2000. This approach was necessary in order to include a reasonable number of individuals with diagnoses of personality disorder. The FPE is undertaken if evidence from the offence, past history, or behaviour during legal proceedings suggests that the offender is mentally disordered. The inpatient FPE is a comprehensive, standardized national assessment system that assesses whether the defendant is legally insane according to the Swedish Criminal Code (Holmberg 1994). Individuals are admitted to one of four of specialist forensic psychiatry units for four weeks and the diagnostic validity of the cases, being based on multidisciplinary clinical examinations over a four week inpatient admission, is high (Bergman et al., 1999). A multidisciplinary team, consisting of a forensic psychiatrist, clinical psychologist and a social worker, performs mental state examinations, personality assessments and psychological testing of the offender, which are supplemented by ward observations. Additionally, a comprehensive life history is obtained, using data from multiple and collateral sources including medical records, school and employment reports, social services notes, police reports and court testimonies. Interviews with parents, school teachers, social workers and employers are also conducted. Diagnoses are recorded according to ICD-9 (1988-1996) or DSM-IV (from 1997 onwards, when standardised assessments instruments, including the Structured Clinical Examination for DSM Disorders, were introduced to supplement the clinical diagnoses). Of the 7,301 individuals on this database from 1988-2000, there were no missing information on either diagnosis or age of the offenders either diagnosis or age of the offenders (Fazel & Grann 2002).

We selected all individuals in the Birth Register born between 1973 and 1986 and merged the individual identification numbers with the FPE register in order to identify controls for the nested case-control study. The year 1986 was chosen as a cut-off in order to take account of the fact that the age of criminal responsibility in Sweden is 15 years, and the sample of FPE individuals went to the year 2000. Of these 732 men and women, we classified those with a principal diagnosis of personality disorder (diagnostic code 301 in ICD-9 and DSM-IV) as cases. Before 1997, ICD-9 was used, and cases were those individuals where the primary diagnosis was personality disorder and no comorbidity with Axis I diagnoses. From 1997 onwards, DSM-IV was used and all individuals with any Axis I diagnoses (including any psychoses) were excluded. We did so in order that the factors associated with PD could be separated from those in other severe mental illnesses. Personality disorder clusters were examined according to the standard grouping: cluster A (schizoid, paranoid, and schizotypal personality disorders); cluster B (histrionic, narcissistic, antisocial and borderline); and cluster C (obsessive-compulsive, dependent and avoidant).

Identification of controls

We identified two groups of controls. First, among the 732 individuals identified from the FPE register with Birth Registry information, those with no psychiatric principal or comorbid diagnosis (absence of codes 290-319 in ICD-9 and DSM-IV on any axis) were identified as controls for the nested case-control study. These controls went through the same selection process as the cases – they were referred and assessed for FPE during 1988-2000.

The second control group were a matched sample from the general population on gender, year of birth and nationality. Ten of these population-based controls were selected for each

case. We excluded any individuals who had inpatient psychiatric episode over 1973-2000, by merging their unique identification numbers with the Hospital Discharge Register. This registry includes all individuals admitted to any hospital for assessment and/or treatment (including secure hospitals and the few private providers of inpatient healthcare) and hence we were likely to exclude individuals who developed severe mental illness. Previous research has estimated that the vast majority of patients with severe mental illness are hospitalized over a ten year period in Sweden (Hansson et al., 2001), although the proportion with PD who are hospitalized is not known but likely to be considerably lower.

Information on risk factors

Information on pre- and perinatal risk factors was taken from the Swedish Medical Birth Register, which represents 99% of all births in Sweden (Hultman et al., 1999; Centre for Epidemiology 2003). This register, which was started in 1973 includes prospectively collected information from standardized medical records on complications during pregnancy, delivery and the neonatal period classified according to the International Classification of Diseases (8^{th}, 9^{th} and 10^{th} editions) (Cnattingius et al., 1990). Information is routinely recorded for each infant beginning from the first antenatal period up to the time when mother and child are discharged from hospital. Risk factor information was divided into the following groups according to previous research: infant-related, and pregnancy and labour-related factors (Cannon et al., 2002). Infant-related factors included: *a)* low weight (<2500 g), *b)* being small for gestational age (defined as birth weight two standard deviations below the mean weight for the given gestational age according to the Swedish foetal growth curve (Marsal et al., 1996); *c)* immaturity not otherwise specified (ICD-8 code 777); *d)* perinatal anoxia and asphyxia (ICD-8 code 776); *e)* neonatal jaundice (ICD-8 code 774 and 775); *f)* perinatal trauma (ICD-8 code 772); g) small head circumference (≤33 cm) at birth. Pregnancy-related factors included: *a)* complications at delivery (spontaneous uncomplicated vaginal delivery *vs.* complicated delivery, including instrumental vaginal delivery, vaginal delivery with malpresentation of the foetus and caesarean section or other complications at delivery including malpresentation, abnormality of the bony pelvis or another cause of prolonged labour); *b)* antepartum haemorrhage (APH; ICD-8 codes 632 and 651); *c)* maternal age at the time of delivery (in complete years); *d)* pre-eclampsia, eclampsia and toxaemia of pregnancy (ICD-8 code 637); *e)* premature delivery (<37 weeks of completed gestation); *f)* premature rupture of membranes (PROM; ICD-8 code 661). Gestational age was generally calculated from the first day of the last menstrual period immediately preceding pregnancy, but use of early second trimester ultrasound measurements became increasingly common during the study period. Smoking status was only recorded in nine individuals in the cases, and therefore not analysed. No reliable information on illegal drug use in the mothers was available. In addition, as a proxy for socio-economic status, information on the occupational background of the cases and the offender controls was extracted. As there was no difference between cases and controls (see Table 1), occupational background was not adjusted for.

Statistical analyses

Logistic regression was used to compare the odds of exposure to adverse perinatal factors in the cases with personality disorder and the controls. Adjustment was made for infant gender in the nested case-control study and gender was matched in the population based investigation. There was no evidence of confounding by maternal age or employment status and these were not adjusted for in the logistic regression. Statistical significance was taken to be at the 5% level. We conducted a multifactorial analysis in the population based investigation, and took those variables significant at the 5% level, and simultaneously entered them into a logistic regression model. In the case-control study, as the absolute

numbers were low, a multifactorial analysis was too unstable to conduct, or those variables in the population based study where absolute numbers were five or less.

Statistical analyses were carried out using SPSS version 16.0. The study was approved by the Research Ethics Committee at Karolinska University Hospital.

Results

Sample demographics

One hundred and fifty people with a principal diagnosis of personality disorder were identified. Most were diagnosed with personality disorder not otherwise specified (n=88; 58.7%). Five (3.3%) were diagnosed with a cluster A personality disorder, 50 (33.3%) with a cluster B, three (2.0%) with both cluster A and B, and four (2.7%) had a cluster C. There were 97 offender controls without any Axis I or Axis II disorder. For the nested case-control study, cases and controls were well-matched on gender, ethnicity and socio-economic background (Table 1).

In the population-based case-control study, we included 1498 mentally healthy controls, which were matched for year of birth and gender. All these controls born during 1973-1983 and 210 (14.0%) were women.

Infant-related risk factors

Low birth weight and immaturity were significantly associated with a diagnosis of personality disorder in both the nested and population-based comparisons (Table 2). For low birth weight, the strength of the association was similar (ORs between 3.3 to 3.4). In the population-based study, other infant-related factors were significant including being small for gestational age (OR=2.5, 95% CI: 1.3–4.7), asphyxia and anoxia (OR=2.4, 1.4–4.1), and small head circumference (OR=1.6, 1.1–2.3).

Pregnancy and labour -related factors

Preterm birth (<37 weeks) was significantly associated with a diagnosis of personality disorder in both the nested (OR=3.3 [1.1–10.2] and the population-based case-control studies OR=2.6 [1.5–4.5] (Table 3). In the population-based study, two other risk factors were significant: young maternal age (OR=2.4, 1.4–3.9), complications at delivery (OR=1.5, 1.0–2.1), and maternal parity of three or more (OR=1.7, 1.1–2.4). There were non-significant associations with antepartum haemorrhage and pre-eclampsia (Table 3).

In the nested case-control study, there was a non-significant association with complications at delivery (OR=1.4, 0.7-2.6). Specifically, there were 31 cases (20.7%) and 15 FPE controls (15.6%) with complicated vaginal delivery; 5 (3.3%) cases and 4 (4.2%) FPE controls with vaginal breech delivery; 2 cases (1.3%) and no FPE controls were delivered by caesarean section. In the population controls, there were 101 (7.3%) with instrumental non-breech delivery and 19 (1.4%) were vaginal breech deliveries. There were 1139 (76.0%) normal vaginal deliveries in the population controls and 77 (80.2%) in the FPE controls compared with 112 (74.7%) in the cases.

Multivariate analyses

In the population-based analyses, we conducted a multivariate regression to examine the variables that were significant on univariate analyses in more detail. In the infant-related factors, asphyxia (OR=1.9, 1.0-3.5) and immaturity (2.2, 1.1-4.6) remained significant. In the pregnancy and labour-related factors, parity (OR=1.8, 1.2-2.7), prematurity (OR=2.4,

1.3-4.2), and young maternal age (OR=2.6, 1.6-4.5) remained significant in the multivariate model.

Discussion

We have examined whether obstetric factors were associated with later diagnosis of personality disorder. The results strongly suggest an increased risk of developing personality disorder among children born with a low birth weight or born preterm. We used two control groups: One with interview-based exclusion of personality disorder and one with population-based controls. There were three main findings. First, low birth weight and prematurity were consistently associated with personality disorder using both comparison groups. Second, asphyxia and complications at delivery were associated with personality disorder in the population-based study; these associations did not reach statistical significance in the nested case-control investigation. A third main finding was that risk factors associated with personality disorder depended on the comparison group. When we used offenders as controls, there were only two significant associations: low birth weight and preterm birth. When we used population controls, most of the pregnancy and infant related factors tested were significantly associated with personality disorder

Strengths and Limitations

One of the study's strengths was the use of different control groups that relied on different assumptions about confounding. The use of 1498 general population controls, who had no history of psychiatric admissions, provided statistical power to test associations across a range of risk factors. The other control group, of 97 offenders, provided a comparison that was known to be free from personality disorder, the first time this has been done to our knowledge. These controls allowed for the ability to test for and adjust for potential confounders. Infant gender was identified as a confounder and adjusted for, other potential confounders such as employment status, a proxy for social class, and maternal age did not meet the conditions for confounding as they were not associated with a diagnosis of personality disorder or the presence of perinatal risk factors. In addition, these offender controls provided for a degree of adjustment for residual confounding.

Other strengths include the high quality of outcome and exposure data. The diagnostic validity of personality disorder in this study was very high, as it involved a four week inpatient assessment with collateral information (Bergman et al., 1999). The cases represented only 2% of the forensic psychiatric evaluations, underlining the difficulty of finding a sample with a primary diagnosis of personality disorder. This low percentage is partly because we excluded any Axis I comorbidity in the selection of cases, as they are themselves associated with perinatal complications (Preti et al., 2000; Cannon et al., 2002) but is consistent with other samples of patients in secure hospitals (Thomson et al., 1997). Finally, the personal identification number system in Sweden allowed merging across two databases with no loss of information on cases or controls, avoiding problems in countries such as the US and UK with aliases in offender populations (Harry 1986; Martin et al., 2005). Risk factor information was collected longitudinally in the National Birth Register with comprehensive coverage, and without knowledge of outcome.

Limitations of the study include the use of a selected sample of individuals with personality disorder - offenders referred for an inpatient forensic assessment. We did this for two reasons. First, it was necessary to sample an enriched population as personality disorder is uncommon in the general population (with prevalences estimated at 5-10% (Torgersen et al., 2001; Coid et al., 2006)), and an adequately powered prospective study in the general population would require structured interviews with more than 1000 people. Despite this,

even though one would expect more cluster B disorders in such a sample, the proportion of those with cluster B disorders in our sample was not dissimilar to a recent population-based study – we found that 35% had cluster B disorders compared with 40% in a general population sample (Coid et al., 2006) but lower than samples of secure hospital patients, where, for example, at least 80% have cluster B disorders in samples when retrospective diagnoses are made (Coid et al., 1999). However, the sample is not generalizable to all those with personality disorder with no more than 5% with either a cluster A or C personality disorder. Population studies, in contrast, report approximately a third with cluster A and a similar proportion with cluster C diagnoses (Coid et al., 2006). The sample we report had a high prevalence of personality disorder NOS diagnoses at 59% - more than 38% reported in a population study (Coid et al., 2006). The high rate of NOS diagnoses may reflect the fact that multiple personality disorders were present, and uncertainty and possible resistance towards a categorical diagnosis. In addition, our sample was 85% male and young, so caution is warranted in generalising the findings to all individuals with personality disorder, and future research can test whether the associations reported are more applicable to individuals with specifically cluster B diagnoses. The average age was 20 years, and it is possible that some of the cases may still develop Axis I disorders.

A second rationale for using a selected population was that it provided for a degree of matching for potential confounders between the cases and controls in the nested case control investigation. Comparison on socio-demographic factors demonstrated that they were well matched. Although we included an additional control group of general population controls who had not been hospitalized with a diagnosis of personality disorder, these controls had not been formally assessed for the lack of personality disorder, which means that we may have underestimated some of the associations in that analysis. Another limitation was that the analysis was limited by lack of more detailed background childhood information such as abuse, poverty, parental absence and unstable household - factors that contribute to personality disorder development (Ellis 1988) and may confound other risk factors, such as obstetric complications. Finally, our study was underpowered to test some associations previously reported for schizophrenia, including maternal diagnoses, such as diabetes and smoking during pregnancy (Hultman et al., 1999; Cannon et al., 2002), and also differences between personality disorder clusters.

Previous work

Our findings are consistent with previous work in predominantly cluster B personality disorders, where specific associations with low birth weight (Dahl & Boerdahl 1993) and prematurity (Bandelow et al., 2005) have been reported. To our knowledge, the reported association with asphyxia in the general population study, which was remained significant on multivariate analysis, is in contrast with a study of 66 individuals with antisocial personality disorder that reported no relationship with chronic hypoxia (Buka et al., 1993). Future research could examine whether this association is specific to personality disorders apart from antisocial, or confounded by violent offending. To our knowledge, previous work has not specifically investigated asphyxia in relation to violent offending.

A meta-analysis of prospective population-based studies of the association between obstetric complications and schizophrenia found that low birth weight, small head circumference and antepartum haemorrhage were associated with increased risk of schizophrenia, while there was no association between preterm birth (<37 weeks) and schizophrenia (Cannon et al., 2002). In our study of personality disorder, we also find increased risks related to low birth weight and small head circumference, but also with preterm birth. Furthermore, a multivariate analysis found that prematurity remained significant although low birth weight and small head circumference did not. Thus similar to schizophrenia, personality disorder is

associated with perinatal risk factors, although which factors they share and their relative contribution needs further clarification and replication in other settings (Clarke et al., 2006). Such research could provide insights in the biological mechanisms underlying psychiatric disorders, and, in particular, common pathways.

Implications

The associations found in this study are not necessarily causal, and may be linked by other common factors independently related to obstetric factors and personality disorders including genetic factors (Thapar et al., 2009; Thapar & Rutter 2009; D'Onofrio et al., 2010). One possibility is that the mothers of the cases may also have had personality disorder (Torgersen et al., 2008), and thus increase the risk of birth complications by abuse of substances or through suboptimal adherence to prenatal health care. On the other hand, studies on discordant monozygotic twins suggest that the associations between perinatal factors and schizophrenia (Nilsson et al., 2005) and attention–deficit/hyperactivity symptoms (Hultman et al., 2007) remain after controlling for genetic and early environmental factors. Other designs will be necessary to explore the role of other potential mediating factors including head injury and childhood trauma (Thapar & Rutter 2009). Mechanisms are required to explain the association the putative risk factors identified in the present report, those of low birth weight and prematurity, and personality disorder. As with schizophrenia, an explanation is that perinatal complications lead to abnormal brain development and function. Brain hypoxia may be the same common pathway for all these complications, although this is likely to interact with genotype and obstetric events (Clarke et al., 2006). Although personality disorder is not commonly conceptualised as a brain disorder, evidence of changes in the prefrontal cortex in antisocial (Raine et al., 2000) and in the prefrontal cortex and amygdala in borderline (Van Elst et al., 2001; Hoerst et al., 2009) personality disordered patients have been demonstrated. The temporal relationship of these changes remains uncertain, but they provide possible pathways for brain pathology to be translated to personality disorder.

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Table 1

Socio-demographic and criminal history characteristics of the individuals with personality disorder (PD) and first set of controls without mental disorder, nested within a cohort of criminal offenders assessed for forensic psychiatric evaluation (FPE).

Characteristic	Individuals with PD, *n (%)*	Offenders with no mental disorder (FPE controls), *n (%)*	Total, *n (%)*	p value	χ^2
Age					
Younger than 18	39 (26.0%)	33 (34.0%)	72 (29.1%)	0.18	1.8
Mean (yrs)	20.2 (SD=2.4)	19.9 (SD=2.9)			
Median (yrs)	20.0	20.0			
Gender					
Male	129 (86.0%)	89 (91.8%)	218 (88.3%)	0.17	1.9
Female	21 (14.0%)	8 (8.2%)	29 (11.7%)		
Nationality					
Swedish	141 (94.0%)	92 (94.8%)	233 (94.3%)	0.87	1.3
Other European	8 (5.3%)	4 (4.1%)	12 (2.9%)		
Turkish	1 (0.7%)	1 (1.1%)	2 (2.8%)		
Occupational background					
Professional	3 (2.0%)	2 (2.1%)	5 (2.0%)	0.32	5.9
Skilled manual	7 (5.3%)	3 (3.1%)	10 (4.0%)		
Unskilled manual	7 (4.7%)	6 (6.2%)	13 (5.3%)		
Students	26 (17.3%)	27 (27.8%)	53 (21.5%)		
Unemployed	65 (43.3%)	36 (37.1%)	101 (40.9%)		
Long-term disability	1 (0.7%)	3 (3.1%)	4 (1.6%)		
Unknown	40 (26.6%)	20 (20.6%)	60 (24.2%)		
Index offence					
Violent crime	109 (72.7%)	69 (71.1%)	178 (72.1%)	0.79	0.07
Non-violent crime	41 (27.3%)	28 (28.9%)	69 (27.9%)		
Total	**150 (100%)**	**97 (100%)**	**247 (100%)**		

Table 2

Infant-related risk factors for later diagnosis of personality disorder: individuals with personality disorder (PD) compared with FPE and general population controls

Risk factor	Individuals with PD, *n* (%)	FPE controls, *n* (%)	Adjusted OR for PD compared with FPE controls (95% CI)*	General population controls, n (%)	Adjusted OR for PD compared with general population controls (95% CI)**
Immaturity, NOS	22 (14.7%)	5 (5.2%)	3.1 (1.2–8.8)	71 (4.8%)	3.4 (2.1–5.7)
Birth weight, g					
<2500	15 (10.2%)	3 (3.1%)	2.6 (0.7–9.6)	49 (3.3%)	3.3 (1.8–6.1)
Asphyxia, anoxia	17 (11.3%)	7 (7.2%)	1.5 (0.6–3.8)	76 (5.1%)	2.4 (1.4–4.1)
Small for gestational age	13 (8.8%)	8 (8.2%)	1.1 (0.4–2.7)	54 (3.7%)	2.5 (1.3–4.7)
Small head circumference	39 (26.7%)	16 (16.7%)	1.8 (0.9–3.5)	277 (18.8%)	1.6 (1.1 – 2.3)
Neonatal jaundice	3 (2.0%)	1 (1.0%)	2.0 (0.2–20.5)	7 (0.5%)	4.3 (1.1–16.9)
Apgar score <7 at 5 minutes	4 (3.8%)	4 (5.1%)	0.7 (0.2–3.0)	17 (1.5%)	2.4 (0.7–7.8)
Perinatal trauma	8 (5.3%)	6 (6.2%)	0.9 (0.3–2.5)	50 (3.4%)	1.6 (0.7–3.7)

*Adjusted by gender of infant.

**Cases and controls were matched by gender and year of birth.

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Table 3

Pregnancy-related risk factors for later diagnosis of personality disorder: individuals with personality disorder (PD) compared with FPE and general population controls

Risk factor	Individuals with PD, n (%)	FPE controls, n (%)	Adjusted OR for PD compared with FPE controls (95% CI)*	General population controls, *n* (%)	Adjusted OR for PD compared with general population controls (95% CI)**
Maternal age <20 years	21 (14.0%)	16 (16.5%)	1.2 (0.6–2.5)	99 (6.7%)	2.4 (1.4–3.9)
Premature delivery	17 (11.3%)	4 (4.1%)	3.3 (1.1–10.2)	70 (4.7%)	2.6 (1.5–4.5)
Maternal parity					
3 and more	40 (26.7%)	19 (19.6%)	1.5 (0.8 – 2.9)	271 (18.1%)	1.7 (1.1–2.4)
Delivery method					
Complications at delivery	46 (30.7%)	23 (23.7%)	1.4 (0.8–4.4)	346(23.4%)[a]	1.5 (1.0–2.1)
Pre-eclampsia & eclampsia	16 (10.7%)	14 (14.4%)	0.7 (0.3–1.5)	97 (6.5%)	1.7 (1.0–3.0)
Premature rupture of membranes	17 (11.3%)	8 (8.2%)	1.4 (0.6 –3.3)	117 (7.9%)	1.5 (0.9–2.6)
Antepartum haemorrhage	4 (2.7%)	1 (1.0%)	2.8 (0.4–25.6)	17 (1.1%)	2.4 (0.8–7.1)

*Adjusted by gender.

**Cases and controls were matched by gender and year of birth.

[a]data missing for 111 individuals.