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Childhood lead exposure, childhood trauma, substance use and subclinical psychotic experiences–a longitudinal cohort study

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ABSTRACT

This study examined the long-term associations between childhood lead exposure, childhood trauma and adult substance use, and subclinical psychotic experiences (SPEs) in the Port Pirie Cohort Study. Adult participants were initially 402 (175 males, 227 females) 25–29 year-olds followed up from the Port Pirie Cohort Study that commenced in 1979 (55.6% of the original cohort). Multiple linear regression analyses were conducted on a sub-sample of 158 participants for which adequate data was available. Variables examined as correlates of positive, negative and depressive SPEs included socioeconomic status at birth, cumulative blood lead level at age 7, maternal mental health, family functioning and cognitive ability at age 11-13, and adverse childhood experiences, alcohol use and cannabis use assessed during adulthood. Cumulative blood lead levels at age 7 were bi-variately associated with the frequency of positive SPEs in adulthood; however this relationship was not significant when other variables were accounted for. Adverse childhood experiences and substance use (cannabis use in particular) were significant correlates of SPEs in adulthood.

1. Introduction

Childhood lead exposure has been identified as a potential risk factor for schizophrenia. Guilarte et al. (2012) proposed a gene-environment interaction involving lead whereby hypofunction of the N-methyl-d-aspartate receptor (NMDAr) complex during critical developmental periods may alter neurobiological processes essential for brain growth and connectivity, resulting in the cognitive and behavioural outcomes associated with schizophrenia. Guilarte et al. (2012) described similarities between the effects of childhood lead exposure and schizophrenia and highlighted the need for prospective studies. There is only one previous study (Opler et al., 2004, 2008), which used an indirect measure of lead in stored maternal serum and found antenatal lead exposure was associated with a two-fold risk of schizophrenia spectrum disorders.

Lanphear et al. (2005) examined data from international population-based longitudinal cohort studies and found that, after covariate adjustment, there was an inverse relationship between blood lead concentration and intelligence quotient (IQ). Childhood lead exposure has been associated with deficits in cognitive, motor, social and behavioural outcomes in many studies (Chiodo et al., 2004; Dietrich et al., 2001; Fergusson et al., 2008; Ris et al., 2004; Surkan et al., 2007), including the childhood Port Pirie analyses (Baghurst et al., 1992; Tong et al., 1996). In the earlier Port Pirie analyses, an increase in average lifetime blood lead exposure from 10 μg/dl to 30 μg/dl was associated with IQ reduction of 4.4–5.3 points at age 7 years (Baghurst et al., 1992); mean levels in boys were slightly higher than in girls at age 11–13 years, but the associations between blood lead and cognitive and behavioural outcomes were much stronger in girls (Tong et al., 2000).

Many of the deficits associated with lead exposure are also evident in schizophrenia (Guilarte et al., 2012; Niemi et al., 2003). A meta-analysis by Khandaker et al. (2011) found the risk of schizophrenia increased by 3.7% for every point decrease in premorbid IQ. These studies infer that subtle damage to the developing brain, caused by environmental toxins such as lead, might

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contribute to the cognitive and behavioural abnormalities seen in schizophrenia.

Whilst schizophrenia is a low prevalence disorder, subclinical psychotic experiences (SPE) are more common. van Os and colleagues (van Os et al., 2000, 2001, 2009; van Os and Linscott, 2012) proposed a continuum of psychotic symptoms in the general population, ranging from mild SPE to persistent psychotic disorder, most commonly schizophrenia. It is argued that potential risk factors for schizophrenia can be extrapolated from predictors of SPE in the general population. Both SPE and schizophrenia are more prevalent in males, users of cannabis and alcohol (for SPE see Scott et al., 2006; Stefanis et al., 2004; Verdoux and van Os, 2002; for psychotic disorders see Barnett et al., 2007; van Os et al., 2001, 2002) and people who have experienced childhood adversity/trauma (for SPE see van Os et al., 2009; Whitfield et al., 2005; for psychotic disorders see Janssen et al., 2004; Ramsay et al., 2011; Ucok and Bikmaz, 2007), particularly sexual trauma (Cutajar et al., 2010; Read et al., 2003).

The present study examined longitudinal data from the Port Pirie Cohort study to investigate whether early lead exposure, childhood cognitive ability, maternal mental health and family functioning, adverse childhood experiences and adult alcohol and cannabis abuse, were associated with a higher incidence of SPE. Specifically, it was hypothesised that higher levels of lead exposure in childhood, maternal mental health concerns and adverse childhood experiences, and lower childhood cognitive ability and family functioning would be associated with a higher incidence of SPE. Furthermore, adult substance use (alcohol and cannabis) were predicted to be associated with a higher incidence of SPE. Finally, earlier research using this cohort consistently found that females were more vulnerable to lead-associated deficits (Baghurst et al., 1992; Burns et al., 1999; for a review, see Searle et al., 2014), thus it was hypothesised that stronger relationships would exist between lead exposure and SPE in females.

2. Method

2.1. Participants

In 1979, 723 babies of women living in Port Pirie (90% of those eligible) were recruited into the initial cohort (McMichael et al., 1986). The present study initially included 402 of these participants (175 males, 227 females) followed up in 2008–2009, 29 years after the original study commenced (55.60% of the original sample). Of these, 356 participants (88.56%) completed a self-report questionnaire and 388 (96.52%) completed a telephone interview; 341 (84.82%) completed both. Participants were aged 25-29 years (mean age=26.94, SD=0.84) at the time of follow-up. Attrition from the childhood to adult wave of data collection has been detailed elsewhere (McFarlane et al., 2013). Participants included in the current analyses were those that participated in the study at age 7 and who had completed both the self-report questionnaire and telephone interview at adulthood follow-up.

2.2. Procedure

The study was approved by relevant human ethics committees. Participant information was sourced from the National Death Index, the Australian Electoral Commission and the Australian White Pages telephone directory. The information sheet, consent forms and self-report questionnaires were posted to the participants and trained researchers conducted the structured telephone interviews.

2.3. Measures

Details regarding the complete childhood measures are found elsewhere (Baghurst et al., 1992; Tong et al., 1996, 1998). The following measures were included in the current study:

2.3.1. Children (data collected 1979–1982)

Socioeconomic status was measured with the use of Daniel's Scale of Prestige of Occupations in Australia (Daniel, 1984) and this information was collected 16 weeks prior to the birth of the participant. In the current sample, scores ranged from 1 to 72 with higher scores indicating lower occupational prestige.

Capillary blood samples, via a finger prick test at 6, 15 and 24 months then annually provided a profile of the child's lead levels throughout the first 7 years and again at age 11–13 years. Blood lead concentrations were measured by electro-thermal atomisation atomic absorption spectrometry (Wigg et al., 1988; McMichael et al., 1988). Age and blood lead concentrations were plotted and average childhood blood lead was calculated as the average area under the curve (Baghurst et al., 1999; Wigg et al., 1988). Age 7 blood lead levels were available for 233 individuals at follow-up; the mean was 17.34μ/dl (SD=5.36 μ/dl, range: 7 μ/dl–31 μ/dl). No significant gender differences were observed (males, M=17.82 μ/dl, SD=5.45 μ/dl; females, M=17.01 μ/dl, SD=5.30 μ/dl).

Participants' cognitive ability was assessed by a trained research psychologist at ages 7 years and 11 years using the Wechsler Scales of Intelligence for Children–Revised (WISC-R; Wechsler, 1974).

2.3.2. Parents (data collected 1979–1982)

The McMaster Family Assessment Device (Epstein et al., 1983) was administered at the 11–13 years assessment, measuring family communication and functioning. Higher scores reflect unhealthier family functioning.

Participants' mothers completed the 12-item version of the General Health Questionnaire (Goldberg and Hillier, 1979) to measure maternal mental health concerns when the children were 11–13 years old. Higher scores indicate poorer psychological well-being.

2.3.3. Adults (data collected 2008–2009)

Subclinical Psychotic Experiences (SPE) were assessed using the Community Assessment of Psychic Experiences (CAPE) (Stefanis et al., 2002), a 42 item self-report measure that assesses attenuated psychotic experiences classified into three sub-categories: positive (e.g. delusional experiences, disordered thoughts, hallucinations), negative (e.g., anhedonia, avolition) and depressive (e.g., pessimism, hopelessness). Two subscales (frequency, distress) can be assessed using this measure; the frequency of symptoms subscale was the focus of the current study.

The Adverse Childhood Experiences (ACE) scale assessed childhood trauma and negative household experiences (Felitti et al., 1998). The original study outlined seven ACE categories and an additional three categories have since been included (Felitti, 2009).

The Alcohol Use Disorders Identification Test (AUDIT) (Saunders et al., 1993) was utilised; a total score is calculated from three subscales measuring recent consumption, dependence, and alcohol-related problems. The WMH-CIDI 3.0 (Kessler and Üstün, 2004) was used to make a diagnosis of lifetime cannabis abuse.

2.4. Data analysis

Data were initially examined for univariate outliers and deviations from normality; all continuous variables had low levels of