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# Completed secondary education among youth with prenatal substance exposure: A longitudinal register-based matched cohort study

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ABSTRACT

*Introduction:* The dual impact of prenatal substance exposure (i.e. alcohol/drugs) and adverse postnatal caregiving environment on offspring secondary education completion is an understudied research area. The aim was to investigate the influence of childhood adversities, out-of-home care, and offspring's mental and/or behavioural disorders on secondary education completion among prenatally exposed offspring in comparison to matched unexposed offspring.
*Methods:* This is a longitudinal register-based matched cohort study in Finland including offspring with a history of prenatal substance exposure and a matched unexposed cohort. The study sample included 283 exposed and 820 unexposed offspring aged 18–23 years.
*Results:* The results showed a time lag in secondary education completion and lower educational attainment overall among exposed compared with unexposed (37.8% vs. 51.0%, respectively). The results from the multivariate logistic regression models showed that the differences in the secondary education completion between exposed and unexposed were diminished in the presence of covariates. A cumulative childhood adversity score and out-of-home care were not associated with secondary education completion in the multivariate models, whereas the different domains of offspring's mental and/or behavioural disorders including psychiatric disorders (AOR 0.65, 95% CI 0.45–0.96), neuropsychological disorders (AOR 0.35, 95% CI 0.23–0.54) and dual psychiatric and neuropsychological disorder (AOR 0.29, 95% CI 0.18–0.48) showed an independent negative effect on secondary education completion.

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*Conclusions:* Inferior educational outcomes may not be directly linked with prenatal substance exposure but may rather reflect the extent of evolving offspring's mental and/or behavioural disorders over time influenced by childhood adversities.

## 1. Introduction

Substance use (i.e. alcohol and/or drugs) during pregnancy represents a major public health concern and a risk for the fetus (Irner, 2012; Riley, Infante, & Warren, 2011). Recent data from Finland indicate that alcohol use during pregnancy is still a major problem (Mårdby, Lupattelli, Hensing, & Nordeng, 2017; Popova, Lange, Probst, Gmel, & Rehm, 2017) and drug use (e.g. marijuana, amphetamine, ecstasy) has been increasing among women of childbearing age since the 1990s (Karjalainen, Pekkanen, & Hakkarainen, 2020). Considering that approximately four out of ten pregnancies are unplanned in Finland among women <30 years old and nearly one in five among women aged ≥30 years (Klemetti, Gissler, Lammi-Taskula, & Miettinen, 2014), there is a risk that the fetus is exposed to substances before pregnancy recognition.

Prenatal alcohol exposure has been associated with impairments in neurocognitive and neurobehavioral functioning, which can appear as deficits in executive functioning (Connor, Sampson, Bookstein, Barr, & Streissguth, 2000; Irner, 2012; Mattson, Crocker, & Nguyen, 2011), and in adaptive behaviour (Dalen, Bruarøy, Wentzel-Larsen, & Laegreid, 2009; Fagerlund et al., 2012). The detrimental effects of prenatal alcohol exposure can manifest as poor academic progress in school and inferior educational outcomes (Olson et al., 1997; Streissguth, 1996; Streissguth et al., 2004). However, only a few studies have investigated educational outcomes among young adults with prenatal alcohol exposure in terms of completed secondary education. These studies show that young adults completely or partly meeting Fetal Alcohol Syndrome (FAS) criteria including a combination of growth retardation, central nervous system dysfunction and typical facial features (Hoyme et al., 2016), have less often completed secondary education (Freunscht & Feldmann, 2011; Rangmar et al., 2015; Spohr, Willms, & Steinhausen, 2007) or post-secondary education (Rangmar et al., 2015).

Studies on prenatal exposure to drugs (e.g. cocaine, marijuana, methamphetamine, opiates) describe deficits in cognitive abilities, and problems with internalizing and externalizing behaviour among children (Ackerman, Riggins, & Black, 2010; Behnke, Smith, Committee on Substance Abuse, & Committee on fetus and newborn, 2013; Lambert & Bauer, 2012; Nygaard, Moe, Slinning, & Walhovd, 2015; Richardson, Willford & Goldschmidt, 2002) potentially contributing to poorer educational outcomes (Goldschmidt, Richardson, Cornelius, & Day, 2004). However, long-term effects of prenatal drug exposure, in terms of completed secondary education, remain an understudied research area.

Offspring with prenatal substance exposure are often exposed to a double burden in life. The negative consequences of prenatal substance exposure are often accompanied by a postnatal caregiving environment challenged by adverse family events and out-of-home care (OHC) (Koponen, Kalland, & Autti-Rämö, 2009; Lambert & Bauer, 2012; Minnes, Lang, & Singer, 2011; Price, Cook, Norgate, & Mukherjee, 2017). Childhood adversities (e.g. neglect, abuse, parental substance abuse, parental mental health disorders, family stress and poverty) can influence child's health, behaviour, and social functioning long-term (Anda et al., 2006; Hughes et al., 2017; Koponen et al., 2020; Norman et al., 2012). Childhood adversities have also been associated with poorer educational outcomes (Berg, Bäck, Vinnerljung, & Hjern, 2016; Erola, Jalonen, & Lehti, 2016; Kääriälä, Berlin, Lausten, Hiilamo, & Ristikari, 2018; Sirin, 2016; Vinnerljung, Bo, Öman, & Gunnarson, 2005).

Secondary education plays a crucial role in the transition to independent adulthood by affecting opportunities to seek higher education and finding employment. Lack of secondary education can increase the likelihood of unemployment and the risk of further social problems in adulthood (Ilmakunnas & Moisio, 2019; McMahon & Oketch, 2013; Sipilä, Kestilä, & Martikainen, 2011). To date, only a few studies have addressed the dual impact of prenatal substance exposure and childhood adversities with inferior educational outcomes among youth (e.g. Howell, Lynch, Platzman, Smith, & Coles, 2006). The aim was, then, to study the prevalence of completed upper secondary education (secondary education hereafter) among offspring aged 18–23 years with a history of prenatal substance exposure (i.e. exposed cohort) in comparison to a matched unexposed offspring (i.e. unexposed cohort). Furthermore, the association of childhood adversities (defined as maternal low socioeconomic status, single parenthood, mental and/or behavioural disorders, substance misuse, criminality, recipiency of long-term social assistance, death) and offspring OHC, and offspring's mental and/or behavioural disorders with completed secondary education among exposed and unexposed offspring was investigated. Considering the direct and indirect effects of prenatal substance exposure on neurocognitive and neurobehavioural functioning (e.g. Behnke, Smith, & Committee on Substance Abuse, & Committee on Fetus and Newborn, 2013; Irner, 2012) and its potential impacts on educational outcomes (Goldschmidt et al., 2004; Streissguth, 2007), the study had three hypotheses: 1) exposed offspring are less likely to have completed secondary education, 2) childhood adversities and OHC are negatively associated with secondary education completion among both exposed and unexposed offspring, and 3) offspring's mental and/or behavioural disorders reduce the likelihood of having completed secondary education among both exposed and unexposed offspring.

## 2. Methods

### 2.1. Study population

The present study is part of a ADEF Helsinki (alcohol and/or drug exposure during fetal life) research project, which is a longitudinal register-based matched cohort study. In the present study, we investigate offspring who were exposed to substances during

pregnancy (i.e exposed cohort) and their matched unexposed cohort at the age of 18–23 years (median follow up 20.1 years, IQR 18.8–21.1).

The exposed cohort consisted of offspring born in 1992–2001 to mothers with a history of gestational follow-up due to substance use. Assessment of substance use among pregnant women was done by public health nurses at the maternity clinics in the Helsinki metropolitan area. The identification of substance use was based on Alcohol Use Disorders Identification Test (AUDIT) (score $\geq$ 8 points), identified use of drugs, nonmedical use of central nervous system medications or opioid therapy, and on the general evaluation of the mother's life situation. The public health nurses were advised to refer pregnant women with identified substance use to the three special antenatal clinics (i.e. HAL clinics) at the Helsinki University Hospital (HUS) for pregnancy follow-up. The HAL (abbreviation for illicit drugs, alcohol, and medications for the central nervous system with misuse potential) clinics at Helsinki University Central Hospital, The Midwifery Hospital, and Jorvi Hospital are special outpatient clinics for pregnant women with substance misuse problems. The pregnant women with identified substance misuse were followed up at the HAL clinics in multidisciplinary service settings every 2–4 weeks and intensified support and easy access to addiction treatment and psychiatric care were offered. Information on the exposed offspring mother's substances used and the type of substances used (i.e. alcohol, cannabis, amphetamine, heroin, buprenorphine, other drugs) were collected by self-reported information and voluntary urine toxicology screening at each visit at the HAL clinic and documented in the hospital medical records. Information on exposure to tobacco smoking during pregnancy was obtained from the Medical Birth Register.

In 1992–2001, 524 pregnant women with identified substance misuse were followed-up at the HAL clinics and gave birth to 640 offspring (i.e. exposed cohort). During 1992–2001 the total number of live-born children in the catchment area was 172 600, and the exposed cohort represented 0.4% of the total population (Sarkola, Kahila, Gissler, & Halmesmäki, 2007). Two exposed offspring could not be linked later due to an incorrect maternal identification number.

A matched unexposed cohort was obtained from the Medical Birth Register. Three non-misuse mother-offspring pairs were obtained for each misuse mother-offspring pair. The unexposed group consisted of offspring (n = 1914) born in 1992–2001 to women (n = 1792) with no registered evidence of alcohol or other substance use one year prior or at the time of delivery. Mother-offspring pairs were matched for five maternal characteristics including maternal age, parity, number of fetuses, a month of birth, and delivery hospital of the index offspring.

Register data were collected identically for exposed and unexposed matched mother-offspring pairs. Information was obtained from Medical Birth Register, Digital and Population Data Services Agency, Hospital Discharge Register (until 1993) or the Care Register for Health Care (since 1994), National Child Welfare Register, Register of Congenital Malformations, Register on Social Assistance, and Criminal Records. Data linkages were done by using the personal identification number assigned to each Finnish citizen at birth or migration. Data collection and anonymization of the data were done by the register keepers. A detailed description of the data collection has been published by Koponen et al., (2020).

The follow-up of the study extends from birth until the end of 2016 or death. The results of the follow-up from birth until the end of 2007 (median 9 years, range 6–15 years) have been published by Sarkola et al. (2007; 2011; 2012) and Kahila, Gissler, Sarkola, Autti-Rämö, and Halmesmäki (2010).

The present study focuses on secondary education, with a focus on offspring aged 18–23 years (i.e. individuals born 1992–1997) in 2015 (i.e. the year from which the latest information of the education is available). Individuals who died before the age of 18 (5 of the exposed, 8 of the unexposed) and individuals who had ever received a diagnosis for intellectual disability (International Classification of Diseases ICD-9 code 317–319, ICD-10 code F70–F79; 5 of the exposed, 6 of the unexposed) were excluded from the analyses. The sample of the present study then includes 283 exposed and 820 unexposed offspring with similar premises to complete secondary education and represents 45.9% of the total study population.

Permission to use the data has been obtained from all authorities maintaining the registers. The Finnish Institute for Health and Welfare performed all the register linkages as the statistical authority and pseudonymized the data. Study subjects were not contacted. The study has been approved by the local ethical committee of The Hospital District of Helsinki and Uusimaa.

### 2.2. Measures

#### 2.2.1. Outcome

*2.2.1.1. Completed secondary education.* The Finnish educational system consists of a comprehensive nine-year education period commonly starting during the year of turning seven years old. The non-mandatory secondary education is a post-comprehensive education, and the most common options are general upper secondary school and vocational education. The 2–4 year general upper secondary education leads to matriculation examination and qualifies for further higher education. The 3-years vocational education is more practice-oriented education and provides general eligibility for further higher education as well.

The annually collected information on secondary education was obtained from the Education Register maintained by Statistics Finland. The information included data on completion of secondary education (no, yes) and the level of completed education (i.e. vocational education, general upper secondary school, and bachelor's degree from University or University of Applied Sciences). These data were available from 2010 until the end of 2015, and the highest completed secondary education level for each offspring was used in the analyses.

### 2.2.2. Covariates

*2.2.2.1. Offspring's demographic variables.* Data on sex were obtained from the Medical Birth Register (female, male), mortality data were obtained from the Cause of Death Register, and information on the offspring's mother language (Finnish, Swedish, other) were obtained from the Digital and Population Data Services Agency.

*2.2.2.2. Offspring's health status at birth.* Birth weight (<2500 g, ≥2500 g), gestational age (<37 weeks, ≥ 37 weeks), Apgar score at 1 min (0–6 points, 7–10 points), and exposure to smoking during pregnancy (no, yes) was obtained from the Medical Birth Register. Data on diagnosis within the Fetal Alcohol Spectrum Disorders (FASD) continuum (no, yes) were obtained from the Register of Congenital Malformations and from the Hospital Discharge Register or the Care Register for Health Care including both inpatient and outpatient hospital visits (ICD-9 code 760.71, ICD-10 code Q86.0). Information on diagnosed Neonatal Abstinence Syndrome (NAS) (no, yes) was obtained from the Medical Birth Register, Hospital Discharge Register or the Care Register for Health Care including both inpatient and outpatient hospital care (ICD-9 code 779.5, ICD-10 code P96.1), and from the hospital chart of HAL clinics.

*2.2.2.3. Out-of-home care.* Taking a child into care (OHC hereafter) is considered an urgent municipal child protective service in the setting of 1) child's biological home environment or child's own behaviour seriously threatens a child's development or health, and 2) non-residential services are considered inadequate. OHC can be voluntary or involuntary (Ministry of Social Affairs and Health, 2013). Data on OHC between 1992 and 2016 were obtained from the Child Welfare Register. This included the OHC episode (no, yes), age at first OHC episode, cumulative length of OHC episodes, and the number of separate OHC episodes.

*2.2.2.4. Offspring's mental and/or behavioural disorders.* Data on the offspring's mental and/or behavioural disorders were received from Hospital Discharge Register or the Care Register for Health Care. A study variable of offspring's primary diagnosis for mental and/or behavioural disorders from inpatient or outpatient hospital care during 1992–2016 was created. This included the following ICD codes: ICD-9 (1992–1995) codes 290–319 (317–319 excluded), and ICD-10 (1996–2016) codes F00-F99 (F17, F70–F79 excluded). Mental and/or behavioural disorders were categorized into four subgroups: no psychiatric (F10–F60 and/or the corresponding ICD-9 codes) or neuropsychological disorders (F80–F99 and/or the corresponding ICD-9 codes), psychiatric disorders only (F10–F60 and/or the corresponding ICD-9 codes), neuropsychological disorders only (F80–F99 and/or the corresponding ICD-9 codes), and dual psychiatric and neuropsychological disorder (both F10–F60 and F80–F99 and/or the corresponding ICD-9 codes).

*2.2.2.5. Maternal characteristics.* Mother's age at offspring's birth (<25 years, ≥25 years) was obtained from the Medical Birth Register. Information on mother's socioeconomic status (low status indicated by manual workers/students/pensioners/others, high status indicated by lower-/upper-level employees/self-employed) was based on maternal occupation during pregnancy, and marital status (married, unmarried) at the time of offspring's birth was obtained from the Medical Birth Register.

*2.2.2.6. Offspring's childhood adversities.* A variable of childhood adversities was computed by including five indicators that describe adverse maternal characteristics that can negatively impact on parenting and caregiving during childhood and thus be associated with inferior educational outcomes (Berg et al., 2016; Erola et al., 2016; Sirin, 2016). These five indicators have occurred before the birth of the offspring or when the offspring has been less than 18 years old; death of a mother, maternal mental and/or behavioural disorder, maternal substance misuse, maternal recipiency of long-term social assistance, and maternal criminality.

Mortality data (no, yes) were obtained from the Cause of Death Register. Mental and/or behavioural disorder (no, yes) was defined as at least one primary diagnoses from inpatient or outpatient hospital care for ICD-9 codes (1987–1995) 290 and 293–319 (303–305 excluded), and ICD-10 codes (1996–2016) F00-F09 and F20-F99 and data were obtained from Hospital Discharge Register or the Care Register for Health Care. Substance misuse (no, yes) was defined as at least one primary diagnosis from inpatient or outpatient hospital care for alcohol and/or drug-related misuse using the following diagnostic codes: ICD-9 codes (1987–1995): 291–292, 303–305, 3570, 4255, 5353, 5710, 5711–5713, 6483, 6555, 9650, and 9696–9697 and ICD-10 codes (1996–2016) E24.4, F10-F16, F18-F19, G31.2, G40.5, G40.51, G40.52, G62.1, G72.1, I42.6, K29.2, K70, K85.2, K86.0, K86.08, O35.4-O35.5, P04.4, R78.0-R78.5, T40, T43.6, T50.2-T50.3, T51, Z71.4, Z72.1–Z72.2. Information on substance misuse was obtained from Hospital Discharge Register or Care Register for Health Care. Data on the maternal criminality (i.e. sentenced to unconditional or conditional imprisonment) (no, yes) between 1985 and 2018 was obtained from Criminal Records.

Social assistance information was obtained from the Register of Social Assistance. Social assistance is defined as the last-resort of financial assistance for individuals and families, and it is intended to be a short-term source of financial aid. Individuals and families living or residing in Finland can apply for social assistance if their necessary expenses are not covered by income and assets. Short-term social assistance was defined as received social assistance at least once 1–9 months during a one year period. Long-term social assistance was defined as received social assistance at least once 10–12 months during a one year period. The information on the use of social assistance covered the years of 2002–2016.

As childhood adversities occur in clusters (e.g. Björkenstam et al., 2015; Björkenstam, Vinnerljung, & Hjern, 2017), we analyzed the cumulative exposure of adversities in four groups including the presence of 0, 1, 2, or 3–5 adverse maternal characteristics (cumulative childhood adversity score hereafter).

### 2.3. Statistical analyses

Chi-squared ($\chi^2$) test was used to compare the categorical variables, whereas The Mann-Whitney *U* test was used to compare nonparametric continuous variables between unexposed and exposed, as appropriate. Univariate logistic regression analyses were used to explore associations between completed secondary education and each covariate separately for exposed and unexposed.

**Table 1**
Descriptive statistics and comparison of the exposed and unexposed cohorts [a].

| | Exposed (n = 283) | Unexposed (n = 820) | p-value |
|---|---|---|---|
| Follow-up time (until the end of 2015) (median, IQR) | 20.2 (18.8–22.2) | 20.1 (18.8–22.1) | 0.769 |
| **Offspring's demographic variables, n (%)** | | | |
| Sex | | | 0.626 |
| Male | 144 (50.9) | 431 (52.6) | |
| Female | 139 (49.1) | 389 (47.4) | |
| Language | | | <0.001 |
| Finnish | 273 (96.5) | 705 (86.0) | |
| Swedish | 8 (2.8) | 55 (6.7) | |
| Other | 2 (0.7) | 60 (7.3) | |
| **Offspring's health status** | | | |
| Birth weight | | | <0.001 |
| <2500 g | 42 (14.8) | 55 (6.7) | |
| ≥2500 g | 241 (85.2) | 765 (93.9) | |
| Gestational age | | | 0.705 |
| <37 weeks | 29 (10.3) | 91 (11.1) | |
| ≥37 weeks | 253 (89.7) | 729 (88.9) | |
| Missing | 1 (0.4) | 0 (0.0) | |
| Apgar score at 1 min | | | 0.296 |
| 0-6 | 11 (3.9) | 22 (2.7) | |
| 7-10 | 270 (96.1) | 798 (97.3) | |
| Exposure to smoking during pregnancy | 224 (79.2) | 163 (19.9) | <0.001 |
| Fetal Alcohol Spectrum Disorder | 31 (11.0) | 0 (0.0) | <0.001 |
| Neonatal Abstinence Syndrome | 14 (4.9) | 0 (0.0) | <0.001 |
| **Out-of-home care** | | | |
| At least one OHC episode | 181 (64.0) | 51 (6.2) | <0.001 |
| Age at the first OHC episode in years (median, IQR) | 3.0 (1.0–7.0) | 12.0 (7.0–14.0) | <0.001 |
| The cumulative lifetime duration of OHC episodes in years (median, IQR) | 10.8 (2.7–16.1) | 1.9 (0.3–5.0) | <0.001 |
| Number of separate OHC episodes (median, IQR) | 3.0 (3.0–2.0) | 2.0 (1.0–2.0) | <0.001 |
| **Offspring's mental and/or behavioral disorders** | | | |
| Categorized mental and/or behavioral disorders | | | <0.001 |
| No psychiatric or neuropsychological disorders | 118 (41.7) | 589 (71.8) | |
| Psychiatric disorders | 54 (19.1) | 87 (10.6) | |
| Neuropsychological disorders | 57 (20.1) | 80 (9.8) | |
| Dual psychiatric and neuropsychological disorder | 54 (19.1) | 64 (7.8) | |
| **Maternal characteristics at offspring's birth, n (%)** | | | |
| Age | | | 0.745 |
| <25 years | 100 (35.3) | 281 (34.3) | |
| ≥25 years | 183 (64.7) | 539 (65.7) | |
| Marital status | | | <0.001 |
| Unmarried | 217 (76.7) | 288 (35.1) | |
| Married | 66 (23.3) | 532 (64.9) | |
| Socioeconomic status | | | <0.001 |
| Low | 173 (66.0) | 320 (40.0) | |
| High | 89 (34.0) | 481 (60.0) | |
| **Adverse maternal characteristics** | | | |
| Death | 32 (11.3) | 5 (0.6) | <0.001 |
| Mental and/or behavioural disorders | 122 (43.1) | 127 (15.5) | <0.001 |
| Substance misuse | 144 (50.9) | 25 (3.0) | <0.001 |
| Social assistance | | | <0.001 |
| No social assistance | 34 (12.0) | 596 (72.7) | |
| Short-term social assistance | 54 (19.1) | 126 (15.4) | |
| Long-term social assistance | 195 (68.9) | 98 (12.0) | |
| Criminal record | 29 (10.2) | 2 (0.2) | <0.001 |
| **Cumulative childhood adversity score** | | | <0.001 |
| 0 | 38 (13.4) | 627 (76.5) | |
| 1 | 82 (20.9) | 144 (17.6) | |
| 2 | 70 (24.7) | 34 (4.1) | |
| 3-5 | 23 (8.1) | 15 (1.8) | |

[a] Comparison of categorical variables between exposed and unexposed cohorts based on $\chi^2$ test, comparison of continuous variables based on Mann-Whitney *U* test, Abbreviation: IQR, interquartile range, Cumulative childhood adversity score includes maternal death, maternal mental and/or behavioural disorder, maternal substance misuse, maternal recipiency of long-term social assistance, maternal criminality.

Spearman correlations were used to explore correlations between the study variables and measure potential multicollinearity (not reported). Due to moderate correlations between the adverse maternal characteristics and the prenatal substance exposure status, a sum variable of the adverse maternal characteristics (i.e. childhood adversity score) was used in the multivariate models to reduce the problems of multicollinearity. Six multivariate logistic regression models were constructed to study associations between completed secondary education and different covariates. The selection of covariates was based on previous research (e.g. Behnke et al. 2013; Berg et al., 2016; Brännlund, Strandh, & Nilsson, 2017; Erola et al., 2016; Kääriälä et al., 2018; Sirin, 2016), data availability, and the statistically significant results from the univariate analyses ($p < 0.05$). The first model evaluated the crude differences in completed secondary education between exposed and unexposed. The second model investigated the differences after adjusting for sex and exposure to smoking during pregnancy. In models 3 and 4, additional adjustments were made for maternal characteristics including socioeconomic status and the cumulative childhood adversity score. Adjustments were made for OHC in model 5 and offspring's mental and/or behavioural disorders in model 6. Odds ratios (OR), and adjusted odds ratios (AOR) with 95% confidence intervals (CI) are reported. The statistically significant level was set to p-value $< 0.05$. IBM SPSS Statistics version 25 was used in the analyses.

## 3. Results

Table 1 describes the characteristics of the study population and differences between the exposed and unexposed cohorts. In the sample of 283 exposed and 820 unexposed offspring, 50.9% of the exposed and 52.6% of the unexposed were males. The median follow-up from birth was 20.2 years for exposed and 20.1 years for unexposed. Of the exposed, 14.8% were categorized as having birth weight less than 2500 g compared to 6.7% of the unexposed. There were no differences in gestational age, and Apgar score at 1 min between exposed and unexposed.

The exposed cohort is a heterogeneous group of exposure to alcohol and multiple substances. Nearly four out of five (79.2%) of the exposed were exposed to maternal smoking during pregnancy compared with less than one in five (19.9%) among unexposed. Only a minority (11.0%) of the exposed had a registered diagnosis within the Fetal Alcohol Spectrum Disorder continuum, and 4.9% were diagnosed with Neonatal Abstinence Syndrome during the neonatal period (Table 1).

A majority of the exposed (64.0%) had a history of at least one OHC episode prior to 18 years of age compared with 6.2% among unexposed. The exposed were of younger age at first OHC episode, the number of separate OHC episodes was higher, and the cumulative lifetime duration of OHC was longer compared with unexposed. Differences were also observed between the exposed and unexposed in the domains of mental and/or behavioural disorders including psychiatric disorders, neuropsychological disorders, and dual psychiatric and neuropsychological disorder, which were more common among exposed compared with unexposed offspring (Table 1).

Regarding the maternal characteristics, being unmarried (76.7% vs. 35.1%, respectively) and from the lower socioeconomic status group (66.0% vs. 40.0%, respectively) were more common among the exposed compared with the unexposed. Regarding offspring childhood adversities, maternal mental and/or behavioural disorders, substance misuse, recipiency of long-term social assistance, and

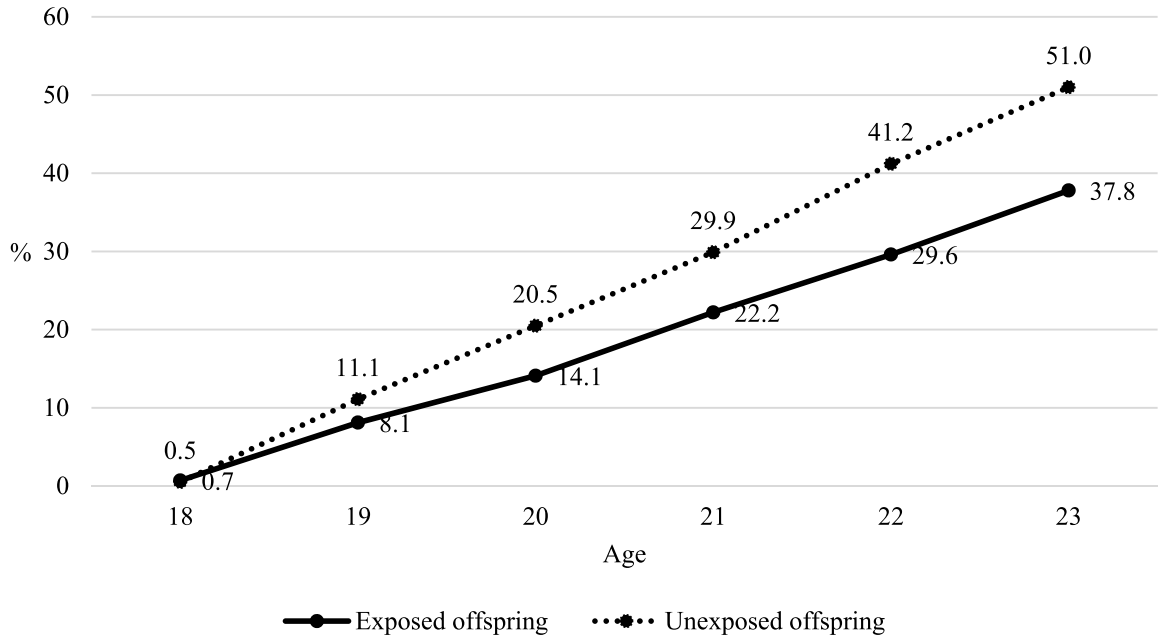


**Fig. 1.** Cumulative proportions of exposed and unexposed offspring with completed secondary education at the age of 18–23 years.

criminality were all more common among the exposed compared with unexposed. In the cumulative offspring's childhood adversity score, the difference between the exposed and unexposed scored increased with an increasing cumulative amount of adverse maternal characteristics (Table 1).

Fewer exposed had completed secondary education compared with the unexposed offspring and the difference in the cumulative proportions of exposed and unexposed offspring with completed secondary education increased linearly with age as presented in Fig. 1. Differences in the level of completed secondary education were also observed with exposed showing a higher level of completed vocational education and a lower level of completed general upper secondary school compared with unexposed (Table 2). Among the 31 exposed offspring with a diagnosis within the FASD continuum, 16 had completed secondary education, 13 of them had completed vocational education and 3 had completed general upper secondary school.

OHC was related to less often completed secondary education and with the level of completed secondary education among unexposed but not among exposed (Table 3a). Offspring's mental and/or behavioural disorders were negatively related both with secondary education completion and level of completed secondary education among both the exposed and unexposed (Table 3b).

The univariate logistic regression analyses were performed for the exposed and unexposed offspring separately to explore associations between completed secondary education and different offspring and maternal covariates. For exposed offspring, of the offspring's mental and/or behavioural disorders, neuropsychological disorders (OR 0.25, 95% CI 0.12–0.52) and dual psychiatric and neuropsychological disorder (OR 0.36, 95% CI 0.18–0.74) reduced the likelihood of completing secondary education. None of the other covariates showed statistically significant associations with secondary education completion (Table 4).

For unexposed, the offspring-related covariates that reduced the likelihood of completing secondary education were exposure to smoking during pregnancy (OR 0.69, 95% CI 0.49–0.97), at least one OHC episode (OR 0.34, 95% CI 0.18–0.64), and the different domains of mental and/or behavioural disorders including psychiatric disorders (OR 0.54, 95% CI 0.34–0.85), neuropsychological disorders (OR 0.51, 95% CI 0.32–0.82) and dual psychiatric and neuropsychological disorder (OR 0.25, 95% CI 0.14–0.46). Of the maternal factors, a mother being <25 years old (OR 0.73, 95% CI 0.55–0.98), having low socioeconomic status (OR 0.65, 95% CI 0.49–0.87) and being a recipient of long-term social assistance (OR 0.47, 95% CI 0.30–0.73) all reduced the likelihood of secondary education completion. None of the other covariates showed statistically significant associations with secondary education completion (Table 4).

Six multivariate models were constructed to study associations between secondary education completion and different covariates (Table 5). The selection of variables for the multivariate models was based on the statistically significant results from the univariate analyses or prior knowledge of the factors associated with educational outcomes. Maternal age at offspring's birth was not included in the multivariate analyses as it was one of the matching criteria.

The crude OR from model 1 showed that the exposed were less likely to have completed secondary education compared with unexposed offspring (OR 0.59, 95% CI 0.44–0.77). The difference in the completion of secondary education between the exposed and

**Table 2**
Comparison of completed secondary education and the level of completed secondary education among exposed and unexposed offspring [a].

| | Exposed (n = 283) | Unexposed (n = 820) | p-value |
|---|---|---|---|
| **Secondary education, n (%)** | | | <0.001 |
| No completed secondary education | 176 (62.2) | 402 (49.0) | |
| Completed secondary education | 107 (37.8) | 418 (51.0) | |
| **Level of completed secondary education, n (%)** | | | <0.001 |
| Vocational education | 76 (26.9) | 184 (22.4) | |
| General upper secondary school | 30 (10.6) | 225 (27.4) | |
| Bachelor's degree | 1 (0.4) | 9 (1.1) | |

[a] Comparison between exposed and unexposed cohorts based on $\chi^2$ test.

**Table 3a**
Comparison of completed secondary education and the level of completed secondary education by out-of-home care (OHC) for exposed and unexposed separately [1].

| | Exposed | | | Unexposed | | |
|---|---|---|---|---|---|---|
| | No OHC episodes (n = 102) | At least one OHC episode (n = 181) | p-value | No OHC episodes (n = 769) | At least one OHC episode (n = 51) | p-value |
| **Secondary education, n (%)** | | | 0.912 | | | 0.001 |
| No completed secondary education | 63 (61.8) | 113 (62.4) | | 365 (47.5) | 37 (72.5) | |
| Completed secondary education | 39 (38.2) | 68 (37.6) | | 404 (52.5) | 14 (27.5) | |
| **Level of completed secondary education, n (%)** | | | 0.898 | | | 0.002 |
| Vocational education | 28 (18.8) | 48 (26.5) | | 174 (15.2) | 10 (11.2) | |
| General upper secondary school | 11 (7.4) | 19 (10.5) | | 221 (19.2) | 4 (4.5) | |
| Bachelor's degree | 0 (0.0) | 1 (0.6) | | 9 (0.8) | 0 (0.0) | |

[1] Group comparison based on $\chi^2$ test.

**Table 3b**
Comparison of completed secondary education and the level of completed secondary education by offspring's mental and/or behavioural disorders for exposed and unexposed separately [1].

| | Exposed | | | | |
|---|---|---|---|---|---|
| | No psychiatric or neuropsychological disorders (n = 118) | Psychiatric disorders (n = 54) | Neuropsychological disorders (n = 57) | Dual psychiatric and neuropsychological disorder (n = 54) | p-value |
| **Secondary education, n (%)** | | | | | <0.001 |
| No completed secondary education | 60 (50.8) | 30 (55.6) | 46 (80.7) | 40 (74.1) | |
| Completed secondary education | 58 (49.2) | 24 (44.4) | 11 (19.3) | 14 (25.9) | |
| **Level of completed secondary education, n (%)** | | | | | 0.003 |
| Vocational education | 40 (33.9) | 15 (27.8) | 9 (15.8) | 12 (22.2) | |
| General upper secondary school | 18 (15.3) | 8 (14.8) | 2 (3.5) | 2 (3.7) | |
| Bachelor's degree | 0 (0.0) | 1 (1.9) | 0 (0.0) | 0 (0.0) | |
| | **Unexposed** | | | | |
| | No psychiatric or neuropsychological disorders (n = 589) | Psychiatric disorders (n = 87) | Neuropsychological disorders (n = 80) | Dual psychiatric and neuropsychological disorder (n = 64) | p-value |
| **Secondary education, n (%)** | | | | | <0.001 |
| No completed secondary education | 255 (43.3) | 51 (58.6) | 48 (60.0) | 48 (75.0) | |
| Completed secondary education | 334 (56.7) | 36 (41.4) | 32 (40.0) | 16 (25.0) | |
| **Level of completed secondary education, n (%)** | | | | | <0.001 |
| Vocational education | 137 (23.3) | 16 (18.4) | 20 (25.0) | 11 (17.2) | |
| General upper secondary school | 190 (32.3) | 19 (21.8) | 11 (13.8) | 5 (7.8) | |
| Bachelor's degree | 7 (1.2) | 1 (1.1) | 1 (1.3) | 0 (0.0) | |

[1] Group comparison based on $\chi^2$ test.

unexposed remained after adjusting for sex and exposure to smoking during pregnancy in model 2 (AOR 0.70, 95% CI 0.51–0.97). In model 3, differences between the exposed and unexposed were not statistically significant after the effect of maternal socioeconomic status was added to the model. Further adjustments for the cumulative childhood adversity score in model 4 and at least one OHC episode in model 5 did not make any change. In the final model, the offspring's mental and/or behavioural disorders were added to the model. Statistically significant differences in the completed secondary education between the exposed and unexposed were not observed. The results indicated that of the offspring's mental and/or behavioral disorders, psychiatric disorders (AOR 0.65, 95% CI 0.45–0.96), neuropsychological disorders (AOR 0.35, 95% CI 0.23–0.54) and dual psychiatric and neuropsychological disorder (AOR 0.29, 95% CI 0.18–0.48) showed an independent negative effect on the secondary education completion compared with offspring without mental and/or behavioural disorders.

## 4. Discussion

In this register-based matched cohort study, we investigated the prevalence of completed secondary education among offspring with a history of prenatal exposure to substances (i.e. alcohol and/or drugs), and whether childhood adversities, OHC and offspring's mental and/or behavioural disorders were associated with secondary education completion in comparison to matched unexposed offspring aged 18-23 years. From the analyses, we excluded offspring with intellectual disabilities, and therefore, the exposed and unexposed cohorts included offspring with similar premises to complete secondary education.

The study shows a time lag in education completion and lower educational attainment overall among offspring with prenatal substance exposure compared with unexposed. This difference was diminished when adjusting for potential confounders, and in the final analyses, the different domains of offspring's mental and/or behavioural disorders appeared as the only independent variable associated with secondary education completion. Thus, the results indicate that offspring's mental and/or behavioural disorders importantly postpone secondary education completion among both exposed and unexposed, and prenatal substance exposure is not independently related with this.

The findings are in agreement with earlier studies indicating that individuals who completely or partly meet Fetal Alcohol Syndrome (FAS) criteria are less likely to complete secondary education (Freunscht & Feldmann, 2011; Rangmar et al., 2015; Spohr et al.,

**Table 4**
Odds ratios (OR) for completed secondary education in relation to covariates for exposed and unexposed offspring separately.

| | Exposed (n = 283) | | Unexposed (n = 820) | |
|---|---|---|---|---|
| | OR (95% CI) | p-value | OR (95% CI) | p-value |
| **Offspring's demographic variables** | | | | |
| Sex | | | | |
| Male (ref) | 1 | | 1 | |
| Female | 1.48 (0.91–2.39) | 0.115 | 0.98 (0.74–1.28) | 0.856 |
| **Offspring's health status** | | | | |
| Birth weight | | | | |
| <2500 g (ref) | 1 | | 1 | |
| ≥2500 g | 1.11 (0.56–2.20) | 0.762 | 1.00 (0.58–1.73) | 0.992 |
| Exposure to smoking during pregnancy | | | | |
| No (ref) | 1 | | 1 | |
| Yes | 0.86 (0.48–1.54) | 0.610 | 0.69 (0.49–0.97) | 0.035 |
| **Out-of-home care** | | | | |
| At least one OHC episode | | | | |
| No (ref) | 1 | | 1 | |
| Yes | 0.97 (0.59–1.60) | 0.912 | 0.34 (0.18–0.64) | 0.001 |
| **Offspring's mental and/or behavioural disorders** | | | | |
| Categorized mental and/or behavioural disorders | | | | |
| No psychiatric or neuropsychological disorders (ref) | 1 | | 1 | |
| Psychiatric disorders | 0.83 (0.43–1.58) | 0.566 | 0.54 (0.34–0.85) | 0.008 |
| Neuropsychological disorders | 0.25 (0.12–0.52) | <0.001 | 0.51 (0.32–0.82) | 0.005 |
| Dual psychiatric and neuropsychological disorder | 0.36 (0.18–0.74) | 0.005 | 0.25 (0.14–0.46) | <0.001 |
| **Maternal characteristics at offspring's birth** | | | | |
| Age | | | | |
| ≥25 years (ref) | 1 | | 1 | |
| <25 years | 0.73 (0.44–1.21) | 0.218 | 0.73 (0.55–0.98) | 0.036 |
| Marital status | | | | |
| Married (ref) | 1 | | 1 | |
| Unmarried | 0.61 (0.35–1.06) | 0.081 | 0.85 (0.64–1.13) | 0.253 |
| Socioeconomic status | | | | |
| High (ref) | 1 | | 1 | |
| Low | 1.51 (0.88–2.58) | 0.132 | 0.65 (0.49–0.87) | 0.003 |
| **Adverse maternal characteristics** | | | | |
| Death | | | | |
| No (ref) | 1 | | 1 | |
| Yes | 2.03 (0.97–4.25) | 0.061 | 0.64 (0.11–3.85) | 0.625 |
| Mental and/or behavioural disorders | | | | |
| No (ref) | 1 | | 1 | |
| Yes | 0.99 (0.61–1.61) | 0.975 | 0.81 (0.55–1.18) | 0.268 |
| Substance misuse | | | | |
| No (ref) | 1 | | 1 | |
| Yes | 0.97 (0.60–1.57) | 0.913 | 0.75 (0.34–1.67) | 0.480 |
| Social assistance | | | | |
| No social assistance (ref) | 1 | | 1 | |
| Short-term social assistance | 0.90 (0.38–2.13) | 0.810 | 0.74 (0.50–1.09) | 0.124 |
| Long-term social assistance | 0.59 (0.28–1.23) | 0.158 | 0.47 (0.30–0.73) | 0.001 |
| Criminality | | | | |
| No (ref) | 1 | | 1 | |
| Yes | 0.40 (0.16–1.01) | 0.051 | NA | NA |
| **Cumulative childhood adversity score** | | | | |
| 0 (ref) | 1 | | 1 | |
| 1 | 0.79 (0.36–1.74) | 0.563 | 0.74 (0.52–1.07) | 0.107 |
| 2 | 0.92 (0.41–2.04) | 0.832 | 0.54 (0.27–1.10) | 0.092 |
| 3-5 | 0.76 (0.35–1.64) | 0.478 | 0.44 (0.15–1.30) | 0.137 |

2007). A major strength of our study in comparison to previous studies is that we were able to adjust for several known confounders associated with inferior educational outcomes including exposure to smoking during pregnancy, childhood adversities, OHC, and the different domains of offspring's mental and/or behavioural disorders. Thus, we were able to show that the association between prenatal substance exposure and secondary education completion was largely related to other maternal substance misuse and offspring-related factors. This stresses the importance of childhood adversities and offspring mental and/or behavioural disorders influencing the time lag in offspring secondary education completion as also indicated by others (e.g. Carta et al., 2001).

Previous research has shown a negative association between childhood caregiving adversities, OHC and offspring's educational outcomes (Berg, Bäck, Vinnerljung, & Hjern, 2016; Erola, Jalonen, & Lehti, 2016; Kääriälä, Berlin, Lausten, Hiilamo, & Ristikari, 2018). In the present study, OHC reduced secondary education completion among unexposed in the univariate analyses. However, either OHC or childhood caregiving adversities were not significantly associated with secondary education completion in multivariate models. OHC provided early and long-term could be protective factor for exposed offspring as their childhood environment is often

**Table 5**
Odds ratios (OR) and adjusted odds ratios (AOR) of completing secondary education in six multivariate logistic regression models.

| | Crude model | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 |
|---|---|---|---|---|---|---|
| | OR (95% CI) | AOR (95% CI) | AOR (95% CI) | AOR (95% CI) | AOR (95% CI) | AOR (95% CI) |
| **Prenatal substance exposure** | | | | | | |
| Unexposed (ref) | 1 | 1 | 1 | 1 | 1 | 1 |
| Exposed | 0.59 (0.44–0.77)*** | 0.70 (0.51–0.97)* | 0.72 (0.51–1.02) | 0.85 (0.57–1.27) | 0.91 (0.60–1.38) | 0.93 (0.61–1.43) |
| **Offspring's sex** | | | | | | |
| Male (ref) | | 1 | 1 | 1 | 1 | 1 |
| Female | | 1.07 (0.85–1.36) | 1.05 (0.82–1.34) | 1.05 (0.82–1.34) | 1.05 (0.82–1.34) | 0.95 (0.74–1.23) |
| **Exposure to smoking during pregnancy** | | | | | | |
| No (ref) | | 1 | 1 | 1 | 1 | 1 |
| Yes | | 0.73 (0.54–0.98)* | 0.79 (0.59–1.08) | 0.83 (0.611.13) | 0.84 (0.62–1.15) | 0.80 (0.58–1.11) |
| **Maternal socioeconomic status** | | | | | | |
| High (ref) | | | 1 | 1 | 1 | 1 |
| Low | | | 0.80 (0.62–1.03) | 0.83- 0.64–1.07) | 0.83 (0.64–1.07) | 0.83 (0.64–1.08) |
| **Cumulative childhood adversity score** | | | | | | |
| 0 (ref) | | | | 1 | 1 | 1 |
| 1 | | | | 0.80 (0.57–1.12) | 0.83 (0.59–1.16) | 0.94 (0.66–1.33) |
| 2 | | | | 0.73 (0.44–1.19) | 0.81 (0.48–1.38) | 0.92 (0.53–1.59) |
| 3-5 | | | | 0.70 (0.41–1.19) | 0.79 (0.45–1.40) | 0.79 (0.44– 1.41) |
| **At least one OHC episode** | | | | | | |
| No (ref) | | | | | 1 | 1 |
| Yes | | | | | 0.78 (0.51–1.20) | 1.17 (0.73–1.86) |
| **Offspring's mental and/or behavioural disorders** | | | | | | |
| No psychiatric or neuropsychological disorders | | | | | | 1 |
| Psychiatric disorders | | | | | | 0.65 (0.45–0.96)* |
| Neuropsychological disorders | | | | | | 0.35 (0.23–0.54)*** |
| Dual psychiatric and neuropsychological disorder | | | | | | 0.29 (0.18–0.48)*** |

Significance indicated at *p < 0.05, **p < 0.01, ***p < 0.001.

challenged by caregiving adversities as also shown previously (e.g. Streissguth et al., 2004). Among unexposed, older age at the first OHC episode and shorter OHC lifetime duration could potentially be explained by child's behavioural problems that per se may be associated with inferior educational outcomes (e.g. Vinnerljung, & Sallnäs, 2008). However, strong conclusions should be avoided due to the lack of data on specific OHC indications and limited study power in subgroup analyses.

In the present study, the different domains of offspring's mental and/or behavioural disorders were more common among the exposed offspring compared with the unexposed. The common mental and/or behavioural disorders, deficits in neuropsychological functioning, in particular, and the association between prenatal substance exposure have been previously reported (Irner, 2012; Koponen et al., 2020 Sandtorv, Hysing, Rognlid, Nilsen, & Elgen, 2017). The negative association between offspring's mental and/or behavioural disorders and secondary education completion among both exposed and unexposed are supported by previous research indicating that mental and/or behavioural disorders can impair educational performance and be associated with inferior educational outcomes, due to difficulties with behaviour, self-regulation, concentration, attention, and executive functioning and cognitive abilities (Brännlund et al., 2017; Howell et al., 2006; Jangmo et al., 2019; Polderman, Boomsma, Bartels, Verhulst, & Huizink, 2010). We have recently shown that childhood adversities and low birth weight are linked with offspring's mental and/or behavioural disorders (Koponen et al., 2020) similar to other studies (Aarnoudse-Moens, Weisglas-Kuperus, van Goudoever, & Oosteriaan, 2009; Björkenstam et al., 2017; Kambeitz, Klug, Greenmyer, Popova, & Burd, 2019). The results of the present study and prior research suggest then that the time lag in completed secondary education may not be a direct cause of prenatal substance exposure but rather reflect the impact of evolving offspring's mental and/or behavioural disorders influenced by adverse experiences during childhood.

Secondary education is important during the transition to adulthood. Low educational attainment can impact several life domains and increase the risk of further social problems, as well as limit occupational opportunities long-term (McMahon & Oketch, 2013; Sipilä et al., 2011). Significant disabilities and limitations in adolescent skills and abilities may challenge the increased demands of independent decision making and responsibility encountered during the transition to adulthood. Consequently, developmental deficits may together with low educational attainment comprise independent living and future employment in adulthood (Moore & Riley, 2015; Spohr & Steinhausen, 2008; Streissguth, 1996). Therefore, substance use identification and counselling during gestation,

offspring development and health follow-up, sufficient social support and addressing special needs in school and education seem important for educational attainment optimization.

### 4.1. Strengths and limitations

Previous research in the field has been criticized for moderate sample size, lack of a control group and variables reflecting postnatal caregiving environment and potential childhood adversities. This study was able to avoid these weaknesses by including a matched unexposed comparison group and accounting for potential confounders (e.g. OHC, offspring's mental and/or behavioural disorders, childhood adversities) known to influence educational outcomes. In addition, our prospective hospital medical record and comprehensive mandatory national register-based study design provided us with the opportunity to avoid data collection inaccuracies related to retrospective self-reported information, low response rates, or recall bias (e.g. under-reporting of adverse events), and problems related to loss to follow-up of study subjects. However, register data only reflects health care utilization, not health care needs, and therefore we may have missed information on less severe health issues not requiring hospital care. Good quality of Finnish register data has, nevertheless, been ascertained previously (Aro, Koskinen, & Keskimäki, 1990; Gissler & Haukka, 2004).

We also lack detailed information on the type, timing and amount of maternal substance use during pregnancy precluding substance-specific analyses. In addition, the study does not include offspring paternal information. We also lack direct information on childhood adversities related to abuse and neglect, domestic violence, peer and school-related adverse events, and child-caregiving interactions. However, OHC as a child welfare intervention generally indicates substantial and significant documentation of child maltreatment, neglect, and/or severe problems in the caregiving environment or in a child's behaviour. Lastly, as this is an observational study, causal links with completed secondary education are challenging to prove.

## 5. Conclusion

In conclusion, the results indicate that offspring exposed to substances during pregnancy and with a normal cognitive level have less often completed secondary education. Furthermore, childhood adversities, out-of-home care, and mental and/or behavioural disorders are more common among exposed offspring compared with unexposed. The results suggest that the time lag in completed secondary education may not be a direct cause of prenatal substance exposure but rather reflect the impact of evolving offspring's mental and/or behavioural disorders influenced by adverse experiences during childhood. A lower final educational attainment level may predispose these offspring to other challenges later in adulthood, and therefore, identification of individuals at risk and early support is important for educational attainment optimization.

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## Declaration of competing interest

No conflicts of interest to declare.

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