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Academic achievement in children born extremely preterm: a cohort study

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ABSTRACT

Objective Children born extremely preterm (EPT) vary greatly regarding academic outcomes, underscoring the need to investigate subgroups in large representative samples. This study aimed to (1) examine academic outcomes in EPT children versus full-term controls and (2) examine the role of maternal education, child sex, maternal origin, cognitive ability and the presence of attention deficit hyperactivity disorder (ADHD) or autism spectrum disorder (ASD) diagnosis.

Design National cohort study.

Setting Sweden.

Patients 12-year follow-up of a cohort study, the Extremely Preterm Infants in Sweden Study, including children born EPT (n=449) and full-term controls (n=365).

Outcome measures Data on school grades (mathematics, Swedish and English) and special education school attendance were obtained from registers.

Exposure EPT group versus controls and subgroup analyses within the EPT group.

Results Compared with full-term controls, children born EPT more often attended special education schools (13.6% vs 0.5%; OR 28.5 (95% CI 6.9 to 117.5)) and those attending mainstream school more often received at least one failing grade (32.3% vs 5.2%; OR 8.7 (95% CI 5.2 to 14.5)). Of children with gestational age (GA) ≤23 weeks, 39% attended mainstream school and passed all three core subjects, compared with 65% of those born at 26 weeks (OR 0.34 (95% CI 0.17 to 0.62)). Among EPT children attending mainstream education, low GA, low maternal education, cognitive impairment and ADHD/ASD diagnosis increased the risk of poor academic achievement.

Conclusions EPT birth was associated with poor academic achievement, but the risk varies substantially within the EPT group, primarily based on cognitive impairment, ADHD/ASD diagnosis and maternal education. However, the risk of poor academic achievement among children born EPT remained after adjusting for confounders and mediators.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Children born extremely preterm (EPT) are at increased risk of academic underachievement.

⇒ However, the effects of EPT birth on educational outcomes vary within the EPT group, and few studies have examined subgroups of children born EPT in representative samples.

WHAT THIS STUDY ADDS

⇒ Low gestational age, low maternal education, cognitive impairment and attention deficit hyperactivity dAttention Deficit Hyperactivity Disorder or autism spectrum dAutism Spectrum Disorder diagnosis, but not child sex and maternal non-Nordic origin, increase the risk of academic underachievement among children born EPT attending mainstream education.

⇒ Cognition contributes the most.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Many children born EPT require extra educational support. However, it is also important to view children born EPT as a heterogeneous group, with some children being at much higher risk of poor educational outcomes than others.

INTRODUCTION

Preterm birth is associated with lower academic achievement,[1 2] most notably in children born extremely preterm (EPT).[2] However, most studies on academic achievement have not investigated EPT subgroups, and those doing so have often relied on small, non-representative samples or on children born before the 21st century. As perinatal care has improved significantly over the past decades, alongside indications of declining academic outcomes in later EPT cohorts,[1 3] updated studies are necessary. Furthermore, many studies have focused on achievement tests rather than school grades. However, achievement tests may not adequately reflect long-term performance, which could explain why school grades show higher predictive value for future academic achievement.[4]

Furthermore, the effects of prematurity on academic outcomes vary within the EPT group, underscoring the importance of investigating factors known to influence academic achievement.[2] Among typically developing children, several factors have been identified, but we still do not know enough about how these factors relate to academic achievement among EPT children. As shown in figure 1, these factors include confounding factors, such as child sex,[5] immigrant background and parental

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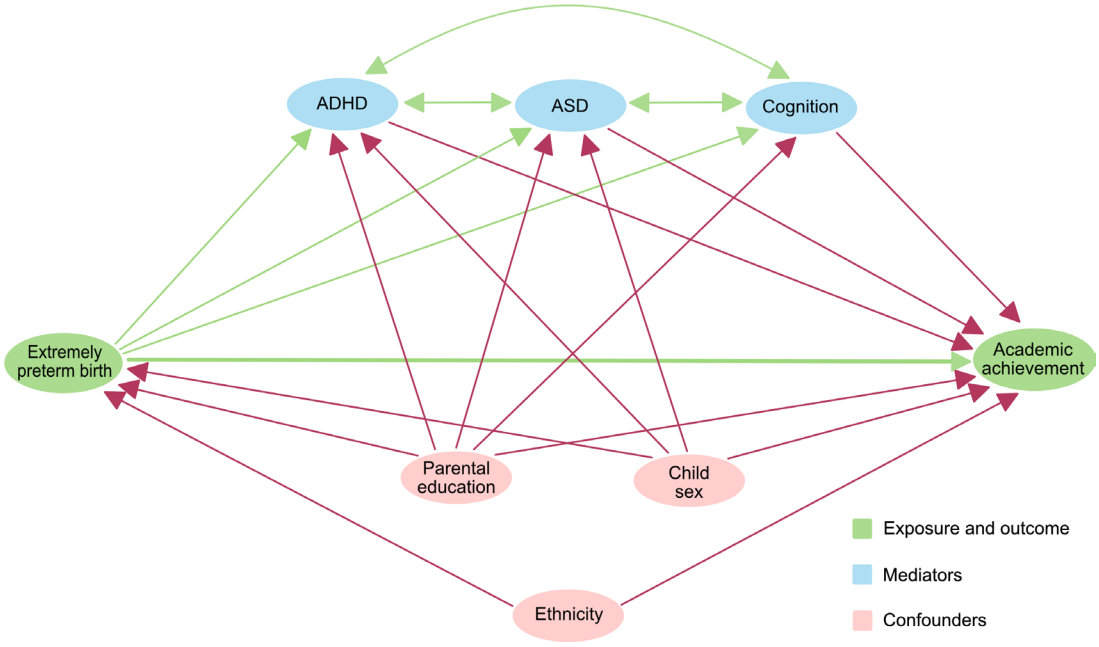

Figure 1 Directed acyclic graph displaying the association between extremely preterm birth and academic achievement and how confounding factors and mediators potentially affect this association. ADHD, attention deficit hyperactivity disorder; ASD, autism spectrum disorder.

education,[6] but also mediating factors such as cognitive impairment[7] and neurodevelopmental disorders such as attention deficit hyperactivity disorder (ADHD) and autism spectrum disorders (ASD).[8–10] Therefore, the present study aimed to (1) compare children born EPT and full-term controls regarding both special school attendance and school grades, controlling for both confounders and mediators and (2) investigate school grades relative to risk factors within children born EPT who attend mainstream education.

METHODS

Participants

Data were collected as part of the 12-year follow-up of the Extremely Preterm Infants in Sweden Study (EXPRESS) study,[11–14] a national, population-based study of all children born EPT (<27 gestational weeks) in Sweden between 1 April 2004 and 31 March 2007. Using the Swedish Birth Registry, which contains all births, we selected a control group of children born at term, matched on place of residence, sex, expected birth date and maternal country of birth. Eligible for the study were 462 children born EPT and 373 matched full-term controls, recruited at ages 2.5 years and 6.5 years. A total of 13 (2.8%) children born EPT and eight (2.1%) of the controls had missing data for academic achievement or special education school attendance; 15 due to insufficient data to make a grade assessment, three attending schools not providing grades (ie, Waldorf schools) and three for unknown reasons. Thus, the study sample consisted of 449 children (202; 45% females) born EPT and 365 controls (168; 46% females). See online supplemental table 1 for background characteristics.[14] Online supplemental table 2 presents descriptive data for children born EPT who attended special education schools versus those attending mainstream education.

Measures

Data on special education school attendance, grades in core subjects (ie, Mathematics, English and Swedish) at the end of the sixth school year and maternal education were collected from Statistics Sweden. Grades were only available for children attending mainstream education, as special education schools in Sweden are primarily for children who meet the diagnostic criteria for intellectual disability (ie, IQ <70 and significant limitations in adaptive functioning). These children are not expected to pass any subject as assessed within mainstream education. Diagnostic codes for ADHD and ASD, received at any time during the child's life, were obtained from the National Patient Register. Swedish grades have six levels (F–A), which were converted to numbers (0–5). We included two primary measures—'special education school attendance' for the entire sample and 'failing at least one core subject' (ie, receiving an F) for the sample attending mainstream education. Secondary outcome measures included the following measures: proportion failing each core subject, core subject grades and grade point average (GPA) for core subjects. Children born EPT (4.1%) and controls (0.8%) who attended Swedish as a second language class had missing data for the subject Swedish but were included in GPA analyses.

We used the International Standard Classification of Education (ISCED)[15] to create categories for maternal education at age 12 years: (1) low (ISCED 0–3; high school or less), (2) medium (ISCED 4–5; university <3 years) and (3) high (ISCED 6–8; university ≥3 years).

At age 12 years, all children participating in EXPRESS were invited for a follow-up, and 310 children born EPT and 206 full-term controls completed a cognitive assessment using the Wechsler Intelligence Scales for Children, Fifth edition.[16 17] We analysed the Full-Scale IQ (FSIQ) scores relative to the full-term controls into categories: no impairment (≥−1 SD; FSIQ≥92.1), mild impairment (<−1 SD to ≥−2 SD; FSIQ 79.1–92.1), moderate impairment (<−2 SD to ≥−3 SD; FSIQ 79.0–66.0) and severe impairment (<−3 SD; < 66.0). Data from the 6.5-year follow-up were used for children with missing data. Thus, no children had missing data on cognitive impairment categories.

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Table 1 Results of logistic regression analyses and Analyses of Variances (ANOVAs) comparing children born EPT with full-term controls, showing unadjusted odds ratios (OR) in model 1 and results adjusted for background variables in model 2.

					Model 1	Model 2
	N	EPT n (%)	N	Full-term n (%)	OR unadjusted (95% CI)	OR adjusted for background variables* (95% CI)
Special education school attendance	449	61 (13.6)	365	2 (0.5)	28.5 (6.9 to 117.5)	26.8 (6.5 to 111.0)
GA 22–23 weeks	46	9 (19.6)	–	–	44.2 (9.2 to 212.0)	41.6 (8.6 to 201.9)
GA 24 weeks	86	18 (20.9)	–	–	48.0 (10.9 to 211.8)	45.90 (10.3 to 203.7)
GA 25 weeks	153	16 (10.5)	–	–	21.2 (4.8 to 93.4)	18.81 (4.2 to 83.7)
GA 26 weeks	164	18 (11.0)	–	–	22.4 (5.1 to 97.7)	21.99 (5.0 to 96.3)
Failing at least one core subject	388	126 (32.3)	363	19 (5.2)	8.7 (5.2 to 14.5)	8.07 (4.8 to 13.6)
Failing mathematics	387	98 (25.3)	362	10 (2.8)	11.9 (6.1 to 23.3)	10.50 (5.3 to 20.7)
Failing English	387	65 (16.8)	363	11 (3.0)	6.5 (3.4 to 12.5)	6.23 (3.2 to 12.2)
Failing Swedish†	371	61 (16.4)	360	7 (1.9)	9.9 (4.5 to 22.0)	8.76 (3.9 to 19.7)
Mean grades for core subjects	**N**	**M (SD)**	**N**	**M (SD)**	**Mean difference‡ (95% CI)**	**Adjusted mean difference* (95% CI)**
Mathematics	387	1.46 (1.26)	362	2.94 (1.44)	1.5 (1.28 to 1.67)	1.4 (1.2 to 1.6)
English	387	2.48 (1.64)	362	3.32 (1.40)	0.8 (0.62 to 1.06)	0.8 (0.6 to 1.0)
Swedish†	371	1.79 (1.27)	363	2.90 (1.31)	1.1 (0.92 to 1.29)	1.0 (0.8 to 1.2)
GPA	388	1.91 (1.18)	363	3.05 (1.20)	1.1 (0.97 to 1.31)	1.0 (0.9 to 1.2)

*Model 2 controlled for background variables: child sex, mother's Nordic versus non-Nordic origin, maternal education.
†Lower n for Swedish as some children attended a Swedish as a secondary language class and therefore did not receive a comparable grade in Swedish.
‡Effect sizes were large for mathematics (d=1.03), Swedish (d=0.83) and GPA (d=0.96) and medium for English (d=0.55).
CI, confidence interval; EPT, extremely preterm; GA, gestational age; GPA, grade point average for grades in mathematics, English and Swedish; M, mean; OR, odds ratio; SD, standard deviation.

Statistical analyses

First, logistic regression analyses for categorical variables or Analyses of Variances (ANOVAs) for dimensional variables were used to compare EPT children and full-term controls. Altogether, five models were used to examine the effects of background variables and potential mediators as displayed in the directed acyclic graph in figure 1. In model 1, unadjusted ORs are presented. In model 2, we adjusted for the following confounding variables: child sex (boy/girl), maternal education (high vs low/medium) and maternal country of origin (Nordic vs non-Nordic origin). Models 3–5 investigated whether group differences remained significant after adjusting for confounding or mediating variables, rather than attempting to find the best possible model. More specifically, we adjusted for normal/mild versus moderate/severe cognitive impairment in model 3; ADHD/ASD (no disorder vs at least one) in model 4; cognition and ADHD/ASD in model 5.

Next, group differences within the EPT group were examined based on GA, background factors (ie, child sex, maternal education, maternal non-Nordic origin) and mediating factors (ie, cognitive impairment, ADHD and ASD). As complementary analyses, we conducted multivariable logistic regression analyses, including all factors simultaneously in the model to account for their overlap. All analyses were carried out using IBM SPSS V.29. Children attending special education schools do not receive school grades; therefore, they were included only in analyses of special school attendance.

RESULTS

Differences between the EPT group and controls

As shown in table 1 (model 1), the odds of attending special education schools were more than 28 times higher in the EPT group (n=61; 13.6%) than in full-term controls (n=2; 0.5%). Children born at 22–23 weeks (n=9; 19.6%) and 24 weeks (n=18; 20.9%) attended special education schools more often than children born at 25 weeks (n=16; 10.5%) or 26 weeks (n=18; 11.0%). Adjusted ORs when controlling for confounding variables (model 2) were similar. As shown in table 2, ORs were also relatively similar (20.75) when adjusting for ADHD/ASD diagnosis (model 4), but decreased substantially (eg, from 28.5 to 5.8 for special education school attendance) when adjusting for cognitive impairment (model 3). Of note, the group difference between EPT and controls remained significant also in model 5, which adjusted for both confounding variables and potential mediators.

As shown in figure 2A and online supplemental table 3A, 344 (94%) of full-term controls attended mainstream education and passed all three subjects, compared with 18 (39%) of children born at 22–23 weeks (OR 0.04 (95% CI 0.02 to 0.08)), 40 (47%) at 24 weeks (OR 0.06 (95% CI 0.03 to 0.10)), 96 (63%) at 25 weeks (OR 0.10 (95% CI 0.06 to 0.18)) and 107 (65%) at 26 weeks (OR 0.11 (95% CI 0.07 to 0.20)).

Regarding school grades (table 1), children born EPT more often received a failing grade (n=123; 32.3%) than controls (n=9; 5.2%). The largest group difference was found for mathematics, where 98 (25.3%) of EPT versus 10 (2.8%) of controls received a failing grade.

Differences within the EPT group

Online supplemental table 4 shows results within the EPT group stratified by the risk factors for children attending special education schools versus mainstream schools. The results below (table 3 and figure 2) present results for children attending mainstream education.

Gestational age

Of children born at 22–23 weeks, 19 (55.4%) failed at least one subject, compared with 39 (26.7%) of children born at 26 weeks. The effect of GA did not remain significant in the multivariable

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Table 2 Results of logistic regression analyses and Analyses of Variances (ANOVAs) comparing children born EPT with full-term controls, showing models when adjusting for potential mediators

	Model 3	Model 4	Model 5
	OR adjusted cognition* (95% CI)	OR adjusted ADHD and ASD† (95% CI)	OR adjusted cognition, ADHD and ASD‡ (95% CI)
Special education school attendance	5.8 (1.3 to 25.5)	20.8 (5.0 to 86.7)	4.5 (1.2 to 24.2)
GA 22–23 weeks	5.9 (1.1 to 31.3)	31.6 (6.4 to 155.7)	5.6 (1.0 to 29.7)
GA 24 weeks	7.3 (1.5 to 35.1)	33.1 (7.4 to 149.3)	6.8 (1.4 to 32.8)
GA 25 weeks	4.2 (0.9 to 19.9)	14.2 (3.1 to 63.8)	3.9 (0.8 to 18.6)
GA 26 weeks	6.7 (1.4 to 31.6)	18.6 (4.2 to 82.0)	6.5 (1.4 to 30.8)
Failing at least one core subject	4.0 (2.3 to 7.2)	6.5 (3.8 to 11.1)	3.6 (2.0 to 6.5)
Failing mathematics	4.9 (2.4 to 10.2)	8.0 (4.0 to 15.9)	4.2 (2.0 to 8.8)
Failing English	2.9 (1.4 to 5.9)	4.8 (2.4 to 9.5)	2.5 (1.2 to 5.2)
Failing Swedish§	4.5 (1.9 to 10.6)	6.2 (2.7 to 14.2)	3.6 (1.5 to 8.6)
Core subject grades	**Adjusted mean difference* (95% CI)**	**Adjusted mean difference† (95% CI)**	**Adjusted mean difference‡ (95% CI)**
Mathematics	0.9 (0.7 to 1.1)	1.2 (1.0 to 1.4)	0.9 (0.7 to 1.1)
English	0.3 (0.1 to 0.5)	0.7 (0.4 to 0.9)	0.3 (0.1 to 0.5)
Swedish§	0.7 (0.5 to 0.8)	0.9 (0.7 to 1.1)	0.6 (0.4 to 0.8)
GPA	0.6 (0.5 to 0.8)	0.9 (0.7 to 1.1)	0.6 (0.4 to 0.7)

*Model 3 controlled for background variables and cognition (no/mild vs moderate/severe).
†Model 4 controlled for background variables and ADHD/ASD diagnosis (no vs at least one diagnosis).
‡Model 5 controlled for background variables, cognition and ADHD/ASD.
§Lower n for Swedish as some children attended a Swedish a secondary language class and therefore did not receive a comparable grade in Swedish.
ADHD, attention deficit hyperactivity disorder; ASD, autism spectrum disorder; CI, confidence interval; EPT, extremely preterm; GA, gestational age; GPA, grade point average for grades in mathematics, English and Swedish; OR, odds ratio.

analyses when controlling for the other factors (ie, background factors, cognitive impairment, ADHD and ASD). As deficits within the EPT group were most pronounced for mathematics, we also investigated specific grades for this subject. Figure 2B (and online supplemental table 3) shows that the proportion of children receiving an F decreased from 45.9% (n=17) for children born at 22–23 weeks to 17.2% (n=25) for children born at 26 weeks.

Child sex, maternal education and maternal country of origin

The proportion failing at least one subject was almost identical for EPT girls (n=58; 31.7%) and EPT boys (n=68; 33.2%), as well as for children with a mother of a Nordic (n=98; 31.8%) versus non-Nordic (n=28; 35.0%) origin. However, for maternal education, 42.3% (n=80) of EPT children having a mother with a high school education or less failed at least one subject compared with 18.8% (n=25) of EPT children of mothers with at least 3 years of university education. The difference between low and high education remained significant in the adjusted analyses.

Concerning mathematics (figure 2C–E), the percentage receiving an F was similar for boys (n=57; 28%) and girls (n=24; 24%), as well as for non-Nordic (n=19; 24%) and Nordic origin (n=95; 31%). For maternal education, a difference was primarily observed between high (n=18; 14%) and low/medium levels (n=63; 34%).

Cognitive impairment, ADHD and ASD

Among children born EPT, the proportion failing at least one subject increased from 13.5% (n=25) for children with no cognitive impairment to 91.7% (n=11) for children with severe impairment. ADHD and ASD were also associated with academic underachievement, with 46 (59.0%) of children with ADHD and 28 (60.9%) of children with ASD failing at least one subject. Cognitive impairment, ADHD and ASD remained significantly associated with academic underachievement in the multivariable analyses.

Concerning mathematics (figure 2F, G), the proportion receiving an F was 9.1% (n=17) for children with no cognitive deficits and 91.6% (n=11) for severe deficits. For ADHD and ASD, the proportion with F was 17% (n=49) for children without any of these disorders, 42.6% (n=23) for children with ADHD only, 38.1% (n=8) for children with ASD only and 70.8% (n=17) for children with both ADHD and ASD. However, please note that some of the subgroups for these comparisons were very small.

DISCUSSION

Compared with controls, children born EPT more often attended special education schools (13.6% vs 0.5%), and children born EPT attending mainstream school more often received at least one failing grade (32% vs 5%). Adjusting for background factors only slightly reduced the ORs, whereas adjusting for mediating factors, especially cognitive impairment, substantially reduced them. However, group differences remained significant even after accounting for both background factors and mediators. When examining differences within the EPT group across several risk factors, considerable heterogeneity was found. For example, among children born at 26 weeks, 65.2% attended mainstream education and passed all core subjects, while the corresponding number among children born at 22–23 weeks was 39.1%. Also, the odds of failing at least one core subject were 18 times higher when comparing EPT children with no vs moderate cognitive impairment. When controlling for the overlap between different risk factors, cognitive impairment emerged as the most important factor, with ADHD, ASD and maternal education also contributing significantly.

The importance of investigating factors within the EPT group

As in previous studies, the present study found that children born EPT are at higher risk of both special school attendance and receiving lower grades, especially in mathematics.[1 18–20] Unlike most previous studies, we included a national cohort of children born in the 21st century and full-term controls, and the follow-up was at 12 years. As we obtained data from registers, almost no data were missing regarding educational outcomes. Thus, we were able to address the most important limitations related to sample bias, attrition, follow-up beyond early childhood and the exclusion of a control group.[3] However, the children born EPT attending special education schools (ie, 13.6%) were excluded from the analyses of school grades.

The role of gestational age

In addition to confirming results from previous research showing differences between children born EPT and controls,[2] we also showed large differences within the EPT group. For example, approximately twice as many children born at 22–24 weeks

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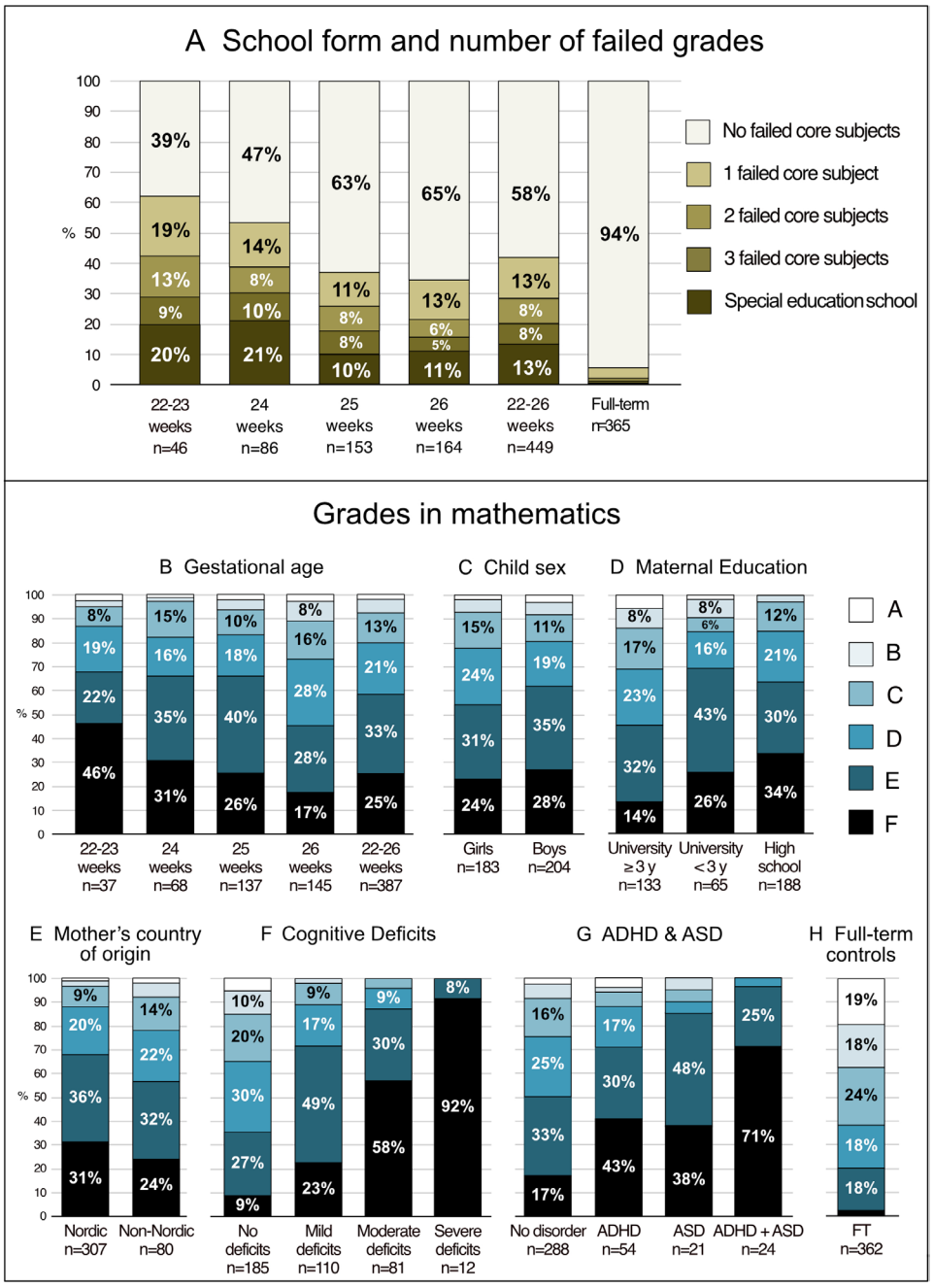

Figure 2 Results of analyses showing either special education school attendance or number of failed grades depending on gestational age (A) or how the risk factors are related to grades in mathematics (B–G) in comparison with full-term (FT) controls (H). ADHD, attention deficit hyperactivity disorder; ASD, autism spectrum disorder.

attended special education schools as children born at 25–26 weeks. In addition, 55.4% of children born at 22–23 weeks and attending mainstream school failed at least one core subject compared with 26.7% of children born at 26 weeks. Thus, there were large differences in academic achievement between children born early and those born later within the EPT group. That said, we believe the proportion of children born at 22–23 weeks who attended mainstream education and also received passing grades (ie, 39.1%) should be considered relatively high. The effect of GA within the EPT group was no longer significant in the multivariable analyses, most likely because GA is strongly associated with cognition both within the EXPRESS study[14] and other studies.[21 22] In addition, the sample sizes were relatively small for children born at 22–23 weeks or 24 weeks, limiting our ability to detect small differences between GA subgroups.

The role of child sex, maternal education and non-Nordic origin

Regarding sex differences in EPT samples, there is some previous research concluding that EPT boys are more prone to negative neurodevelopmental outcomes compared with EPT girls.[23 24] However, a relatively recent meta-analysis challenged this assumption as it failed to find sex differences for either cognitive impairment or behaviour problems.[25] With regard to academic outcomes, most previous studies have only investigated

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Table 3 Comparisons within the EPT group (only children attending mainstream education) with regard to failing at least one core subject based on the different risk factors

	N	Failing at least one subject n (%)	Unadjusted OR (95% CI)	Adjusted* OR (95% CI)
Gestational age				
GA 22–23 weeks	37	19 (55.4)	2.9 (1.4 to 6.1)	1.9 (0.8 to 4.8)
GA 24 weeks	68	27 (39.7)	1.8 (1.0 to 3.3)	1.1 (0.5 to 2.4)
GA 25 weeks	137	41 (29.9)	1.2 (0.7 to 2.0)	0.7 (0.4 to 1.4)
GA 26 weeks	146	39 (26.7)	(Reference)	(Reference)
Child sex				
Male	205	68 (33.2)	1.1 (0.7 to 1.6)	1.2 (0.7 to 2.0)
Female	183	58 (31.7)	(Reference)	(Reference)
Mother's country of origin				
Nordic	308	98 (31.8)	(Reference)	(Reference)
Non-Nordic	80	28 (35.0)	1.2 (0.7 to 1.9)	0.7 (0.4 to 1.4)
Maternal education				
High school or less	189	80 (42.3)	3.2 (1.9 to 5.3)	3.2 (1.6 to 6.1)
University <3 years	65	21 (32.3)	2.1 (1.1 to 4.1)	1.5 (0.6 to 3.5)
University ≥3 years	133	25 (18.8)	(Reference)	(Reference)
Cognitive impairment				
No	185	25 (13.5)	(Reference)	(Reference)
Mild	110	30 (27.3)	2.4 (1.3 to 4.4)	1.9 (1.0 to 3.7)
Moderate	81	60 (74.1)	18.3 (9.5 to 35.1)	15.2 (7.4 to 30.6)
Severe	12	11 (91.7)	70.4 (8.7 to 569.2)	46.2 (5.1 to 414.6)
ADHD				
No disorder	310	80 (25.8)	(Reference)	(Reference)
ADHD	78	46 (59.0)	4.1 (2.5 to 6.9)	2.4 (1.2 to 4.6)
ASD				
No disorder	342	98 (28.7)	(Reference)	(Reference)
ASD	46	28 (60.9)	3.9 (2.1 to 7.3)	2.6 (1.2 to 5.8)

*Adjusted OR refers to the results of the multivariable logistic regression when including all risk factors in the same model (ie, GA, child sex, mother's country of origin, maternal education, cognitive impairment, ADHD and ASD).
ADHD, attention deficit hyperactivity disorder; ASD, autism spectrum disorders; EPT, extremely preterm; GA, gestational age.

sex differences within the EPT group or controlled for sex. The present inclusion of a full-term control group enabled differentiation of differences related to sex per se or a consequence of preterm birth. Our findings are consistent with those of the EPICure study,[20] which showed that educational achievement is not disproportionately affected by EPT birth in boys compared with girls.

Maternal education is often used as a proxy for socioeconomic status, and previous research shows that both genetic and environmental factors explain associations with a child's academic achievement.[26 27] Our analyses within the EPT group indicated that having a mother with low/medium education substantially increased the risk of failing at least one core subject. Previous research suggests that the buffering effect of high parental education applies to conditions such as ADHD, cerebral palsy, diabetes and asthma but not to ASD and epilepsy.[28] While many highly educated mothers can provide good academic support for their child, it is often not possible to compensate for the multiple impairments associated with EPT birth.[29–32]

Maternal non-Nordic origin was not found to be a significant risk factor. However, in the EXPRESS study, all children were born and raised in Sweden, and perhaps the country of origin would constitute a risk in a sample of children who had immigrated more recently.

The role of cognitive impairment

Cognition has previously been shown to be a significant predictor of academic achievement in population-based samples,[7] and children born EPT are at much increased risk of cognitive impairment.[32] We therefore considered cognitive impairment as an important factor in the association between EPT birth and academic outcomes. In the within-group differences, children born EPT with severe cognitive impairment were at much higher risk of failing at least one core subject (91.7%) compared with children with mild (27.3%) or no deficits (13.5%). This finding is consistent with previous studies of EPT samples, also showing that cognition is a significant predictor of academic performance.[19 20] However, the group differences between children born EPT and controls remained significant when adjusting for cognitive impairment.

The role of ADHD and ASD

Previous research has demonstrated that ADHD and ASD are strongly associated with academic underachievement[8–10] and that EPT birth is associated with an increased risk of neurodevelopmental disorders.[33 34] However, previous studies on academic underachievement in EPT samples have not investigated the role of ADHD when also controlling for cognitive abilities. The exception is one study[35] showing that ADHD among children born EPT predicted slower academic progress across the first

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three school years, independent of cognitive abilities. These findings align with our results, which showed that a significantly larger proportion of children born EPT with either ADHD or ASD (≈60%) failed at least one core subject compared with children without these diagnoses (≈26–29%). Importantly, the effects of ADHD and ASD remained significant when controlling for factors known to be associated with these disorders (ie, GA, cognition and maternal education). However, for ASD, the number of children was very small (n=45), making replication of these findings necessary before drawing conclusions.

Strengths and limitations

An important strength of the study was the use of data from a national cohort of EPT children without loss of participants. Thus, the dataset was unbiased and large enough to examine subgroups based on gestational age, background factors and potential mediators of the association between preterm birth and academic achievement. Regarding limitations, we had some missing data on cognition at 12 years, and we relied on the categorisation of cognitive impairment from the 6.5-year assessment for these children. Although Full-Scale intelligence scores are highly stable across childhood,[36] obtaining more detailed information on the cognitive deficits of all children would have been valuable. Although the sample size allowed subgroup analyses, some subgroups were small, limiting our ability to detect small differences and potentially making results unstable for some subgroups. Thus, it is important to replicate our findings using a larger sample. Finally, the register data used in this study included only special education school attendance, not special education within mainstream education.

CONCLUSIONS

The results of the present study show that children born EPT are at significantly higher risk of poor academic outcomes than full-term controls. However, a large proportion (39.1%) of children born at 22–23 weeks attended mainstream school and passed all three core subjects. Our results also indicate that it is important to examine within-group factors, as some EPT children are at much higher risk of poor academic achievement than others. Interestingly, group differences between children born EPT and full-term controls remained significant even when considering both confounders and mediators. Thus, future studies should examine what other factors besides background factors (eg, child sex, immigrant background and maternal education), cognition and ADHD/ASD diagnosis that may account for the difference in academic achievement between children born EPT and controls.

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