Title: Age at attention-deficit hyperactivity disorder (ADHD) diagnosis and educational outcomes by parental education

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Introduction

ADHD is a common neurodevelopmental disorder affecting individuals throughout life course that may lead to adverse educational outcomes in adolescence and early adulthood – such as lower school performance, and higher risk of school dropout – and predict lower educational attainment later in life.[1–13] Still, earlier studies comparing treated and non-treated individuals have suggested that these outcomes could be improved with ADHD treatment, and hence, early diagnosis is often recommended.[3–5]

ADHD is diagnosed more often in childhood than adolescence, and more often and earlier for boys than girls.[14–17] Additionally, ADHD is most often diagnosed for individuals with low parental education,[17–20] and some evidence suggests that they are diagnosed earlier than individuals with high parental education.[17,21] Still, the evidence is contradictory, as another study found that low maternal education may be associated with undetected ADHD in childhood which could lead to a delayed diagnosis.[22]

A delayed diagnosis among individuals with low parental education could pose even more obstacles in improving school performance, and continuing studies in upper secondary or tertiary education, as educational attainment is often intergenerationally inherited.[23] Earlier studies have shown, that in absolute differences low parental education predicts lowest school performance among ADHD diagnosed individuals,[7–9] even though relative differences are still larger among the diagnosed individuals with high parental education in comparison to non-diagnosed peers.[7,8] However, no studies have compared whether the age at diagnosis and educational outcomes differ between individuals with low and high parental education.

Data and methods

We used data from national registers (1990–2020) on individuals born in Finland between 1990–1999 to assess the association of age at diagnosis and educational outcomes differ between low and high parental education. We identified age at first ADHD diagnosis with healthcare data from the Finnish Institute for Health and Welfare (THL), and ADHD medication purchases from the Social Insurance Institution of Finland (Kela). Additionally,

datasets provided by Statistics Finland enabled the linkage of demographic and educational information, as well as information on parental characteristics.

From the initial sample (N = 620,656) we excluded those with any diagnosis of an intellectual disability (ICD-10: F70-79) (1.0%). Then we excluded those who emigrated (2.6%) or died (0.8%) before age 20, individuals with missing information in any of the covariates (0.1%), and those who were diagnosed before age six (0.1%), as diagnosis before preschool age is more prone to misdiagnosis.[1] Lastly, we excluded individuals with a diagnosis after age 20 but before 2021 (2.0%). The final sample consisted of 579,459 individuals, whom we followed for the first ADHD diagnosis between ages 6–20.

Educational outcomes

For birth cohort 1990–1999 in Finland, compulsory education consisted of primary and lower secondary education that was usually attended from age 7 to age 16.[24] We measured school performance with final grades at the end of compulsory education from applications to upper secondary education (representing 98.7% of the sample), and calculated grade point average (GPA) (4 fail – 10 excellent) of compulsory theoretical subjects. School dropout (no, yes) was identified for those who had not completed an upper secondary degree and were not enrolled in upper secondary or tertiary education at age 20.

Age at ADHD diagnosis

We used healthcare data to identify the first clinically recorded ADHD diagnosis (ICD-9: 314, ICD-10: F90), purchase of ADHD medication (ATC-codes: C02AC02, N06BA01, N06BA02; N06BA04; N06BA09; N06BA12) or special refund entitlement of medicines (national code: 331) – whichever was recorded first – and calculated age at diagnosis by calendar year. The same approach to identify ADHD diagnosis has been successfully implemented in a previous study.[17]

Analysis

We used linear regression with robust variance estimator to assess the association of age at diagnosis (6-20) and GPA at the end of compulsory education (age ~16), and linear regression to predict school dropout at age 20. Results from linear regression models are presented as predicted probabilities that are derived with marginal standardization.[25] To assess differences by parental education in the associations, all models included interaction of age at diagnosis

and parental education (basic, secondary, tertiary). The models were adjusted for birth year (1990-1999), region of residence (n = 21), and sex (male, female) assigned at birth, to control for temporal changes, area-level differences and sex-differences in both ADHD diagnostics and educational outcomes.

Results

Table 1. Descriptive information of age at diagnosis and educational outcomes by parental education

		Parental education						
		Basic		Secondary		Tertiary		
		ADHD diagnosis						
		Yes	No	Yes	No	Yes	No	**Total**
	N	1,927	35,621	11,114	387,340	2,921	141,269	579,459
Age at diagnosis	Mean	11.6	N.A.	11.9	N.A.	12.9	N.A.	12.4
	SD	4.2	N.A.	4.4	N.A.	4.6	N.A.	4.3
GPA at age 16*	Mean	6.6	7.0	6.8	7.5	7.4	8.3	7.7
	SD	0.8	1.0	0.9	1.0	1.0	0.9	1.1
School dropout at age 20	%	37.8	21.0	20.5	7.6	10.7	2.9	7.7

* GPA missing for 1.3%

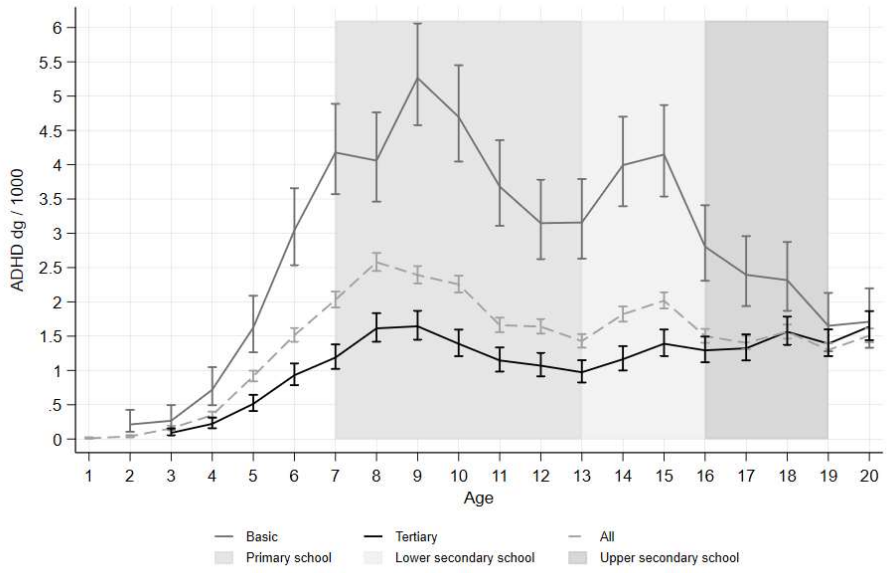

Figure 1. Incidence of ADHD diagnosis (per 1000 individuals) by age at diagnosis and basic and tertiary parental education.

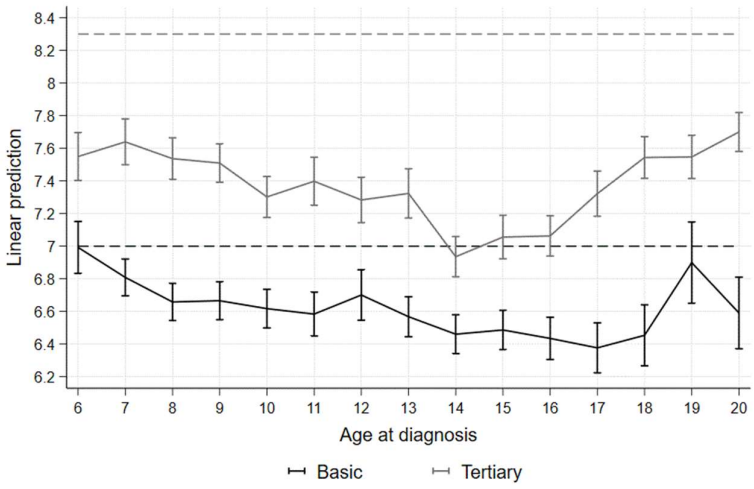

Figure 2. Linear prediction of age at ADHD diagnosis and grade point average (GPA) at the end of compulsory education (age ~16) by basic and tertiary parental education. Dashed line of same color: reference group of individuals without a diagnosis.

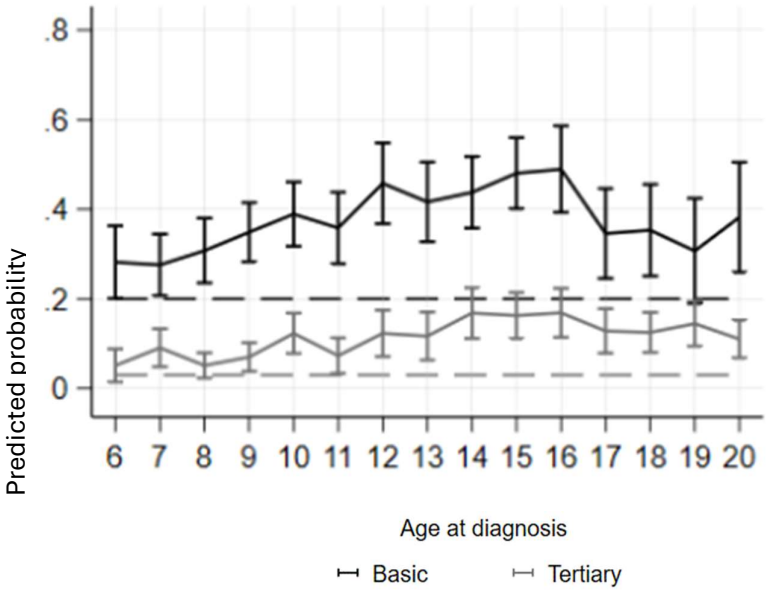

Figure 3. Predicted probability of age at ADHD diagnosis and school dropout at age 20 by basic and tertiary parental education. Dashed line of same color: reference group of individuals without a diagnosis.

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