



Article

# A Chronic Disease in Adolescence and Selection to an Educational Path – a Longitudinal Study

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**Abstract:** Chronic disease may affect adolescents’ educational success. We study if adolescents with a somatic chronic condition have lower school performance, lower odds for academic education, and a delayed start of upper secondary studies. The seventh graders in the Helsinki Metropolitan Region, Finland, were invited to participate in a school survey in 2011 and the ninth graders in 2014. The respondents (2011, N=8 960; 2014, N=7 394) were followed using a national application registry until 2017. The chronic conditions were asthma, diabetes, and epilepsy. Outcomes were grade point average (GPA), study place in an academic school and delayed start of secondary education. Adolescents with a chronic disease needing medication had lower GPA in both grades. Chronic disease with medication in the 7th grade predicted higher odds for the non-academic track (OR=1.3) and the delayed start (OR=1.4). In the 9th grade, chronic disease predicted non-academic studies univariately (OR=1.2) and was not associated with delayed start. The somatic chronic condition with medication, particularly epilepsy, slightly lowers students’ school performance, which is a mediator between the chronic condition and selection into educational paths. Compared to gender and parents’ education, and particularly to GPA, the role of chronic conditions on educational outcomes is small.

**Keywords:** school performance; academic path; lower secondary school; asthma; diabetes; epilepsy

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## 1. Introduction

Low education is a strong predictor of poor health and early death in adult age [1,2]. In adolescence, poor academic achievement [3] and dropping out of education [4] increase the risks for poor health outcomes. Critical decisions on education taken in adolescence shape the pathways from childhood socioeconomic positions towards one’s own educational and socioeconomic career. Educational resources obtained during education may impact health through various mechanisms. Among these are knowledge and skills which may affect a person’s cognitive functioning, readiness to receive and apply health-related information, as well as an ability to communicate and use health services [5]. Health literacy gained during education has been observed as a potential mechanism through which an individual’s educational resources safeguard their health [6].

In many European countries, students are sorted relatively early (before age 13) into separate tracks, whereas in other countries (e.g., Finland, the other Nordic countries) all students follow mainly the same curriculum through their primary and lower-secondary school [7,8]. While choices for educational paths are available, they may be limited by

economic, geographical, or cultural conditions, parents' education, or individual reasons like poor health. International PISA studies have shown how socio-economic position of the family shapes a child's academic performance [9]. Other studies have shown how the material, cultural and intellectual resources owned by the families influence the children's educational choices and shape their careers [10]. Children who are not able to use of the educational opportunities are at risk of experiencing disadvantage over their life course, like difficulties in entering the labour market or finding an economically rewarding position [11,12].

In turbulent years of adolescence with its special developmental tasks, a chronic condition brings an extra challenge for schooling and learning. Over 10% of adolescents have a chronic disease [13], which may disturb their coping with schoolwork, lower their academic engagement, and increase school absenteeism. Students with a chronic condition more often repeat a grade, encounter academic challenges, and have higher school absenteeism compared to those without [14,15]. Students with a chronic condition also have lower educational attainment; they less often achieve high school diploma or college graduation and drop out of education more often than their healthy peers [14,16–19]. Research on educational outcomes has often concentrated on studying the impact of mental health problems, but research on the impact of somatic diseases is scarce. For example, analysis of a register-based follow-up data from a Finnish 1987 birth cohort showed that the probability of the NEET status (not in education, employment, or training) was higher for adolescents who received treatment for psychiatric disorders [20].

The setting for our study is Finland, a Nordic welfare society where educational career choices take place late, at age 16 and where school health service, school welfare groups [21] and three-tiered learning support [22] are available in all schools. Specialist health care takes care of most of the children with chronic conditions. At the end of the nine-year-long comprehensive school, students apply for the upper-secondary education. They are sorted according to their application preferences and grade point averages (GPA). The upper secondary schools are divided into two main lines: academic (general upper-secondary) and vocational track. Those, who are unsure about their study choice, can continue in the 10th grade to refine their further study plans, and improve the grades in their graduation report. Even though there are alternative routes, those selected to vocational schools, have higher odds for lower education later in life [23,24].

We study here, if adolescents with a serious somatic chronic condition have lower GPA in their graduation reports, lower odds for academic education and a delayed start of upper secondary studies.

## 2. Materials and Methods

### 2.1. Study design and participants

Learning and health of students from the Helsinki Metropolitan Region were surveyed in the 7th grade (12-13-year-olds, 2011) and in the 9th grade (15-16-year-olds, 2014) (MetLoFin study). All comprehensive schools in the region with grades 7<sup>th</sup> and 9<sup>th</sup> were invited, thus constructing a total sample of the students in the region. In this study, participants from special schools (2011, N=4; 2014, N=16) were excluded.

The protocol was approved by the Ethical Committee of the Finnish Institute for Health and Welfare. Parental consent was obtained in two of 14 municipalities where local authorities required it. Information letters were sent to parents in other municipalities. The on-line surveys were conducted as a part of normal schoolwork. Participation was voluntarily. Students were instructed that they can decline to answer any question or withdraw from the survey at any time. [25]

Registry data on students' applications for upper secondary schools were obtained from the Finnish National Agency for Education. This is a national registry covering all upper secondary schools in Finland. In practice all students apply via the Joint Application System when completing the ninth grade. The selection is based on school marks

from the graduation report and students' preferences. There are two general application rounds each year followed by additional rounds where students can apply for vacant places. The applications were followed from spring 2014 (graduation time) to spring 2017. The survey answers and the joint application system data were merged. Of 13 012 students in 2011, 8 960 (69%) from 127 schools answered the questionnaire and had application data available. In 2014, the corresponding numbers were 7 394 of 13138 (56%) and 124.

## 2.2. Outcome variables

Three outcome variables were used: *Grade point average (GPA)*, *Non-academic track*, and *Delayed start* of upper secondary school. *GPA* in the graduation report (end of the 9th grade) was computed as the mean of school marks for foreign language, mother tongue, math, and science (mean of physics, chemistry, biology, geography) obtained from the joint application system. In Finland, 4 is failed and 10 is the best. *GPA* was used as a decimal number or categorised (high=9-10, middle=7-8.99, low=4-6.99).

*Non-academic track* consisted of students who were selected to vocational schools (2011, n=3 134; 2014, n=2 444) and those who had no study place according to the registry (2011, n=264; 2014, n=200). The last group was placed here because they were likely selected to vocational schools for open places after the application period, but information had not been reported to the registry. The final variable was dichotomous: academic vs. non-academic track. The latest accepted application was used to place the student. Some students had participated in the survey of the same cohorts in 2016 [26]. If a student was found in a different track than the registry placement showed and had not reapplied after 2016, the participant's placement was revised (2011, N=91; 2014, N=85).

*Delayed start*. Some students applied several times because they were not accepted, had not got a desired place, or had interrupted. Those who did not continue studies directly after graduating, had a delayed start.

## 2.3. Explanatory variables and covariates

*Chronic disease*. We selected somatic diseases likely to disturb schoolwork, using earlier literature and medical knowledge: asthma, diabetes, and epilepsy, based on students' self-reports to the question: "Do you have a chronic disease or disability". In addition, the following diseases were asked: asthma, musculoskeletal condition, diabetes, allergic rhinitis, hay fever or other allergy (separated in 2014), epilepsy, mental health problem, other. Students were further asked if they used regularly or almost regularly prescribed medication and for which disease: asthma, diabetes, allergic rhinitis or hay fever, other allergy, epilepsy, mental health problem, pain, and aches, and other. Students could tick several options in both questions. The final variable was categorised: no chronic disease, chronic disease without medication, and chronic disease with medication.

Cross-tabulations of the above questions showed some inconsistencies and implausible answers. We removed respondents (2011, n=1; 2014, n=109) who reported an unconvincing number of diseases/medicines ( $\geq 5$  in 2011;  $\geq 6$  in 2014). Most of those had ticked all options. Second, we checked open answers to the options "other disease" and "other medicine". We excluded participants with inappropriate and improper answers (e.g., sexual-related matters, YouTube links, joking, mickey-taking). Finally, we checked case by case those who reported epilepsy or diabetes. We used open text and the question on harm experience due to a disease (this question could not be used otherwise, because it did not separate between diseases) and excluded those with implausible combinations. Altogether 20 cases of 2011 and 168 cases of 2014 data were removed. The final variable was classified: chronic disease without medicine, chronic disease with medicine, no chronic disease. The diseases in the variable were asthma, diabetes, and epilepsy.

*Parents' education.* Parents' education was dichotomous "high" and "middle/low". Matriculation examination and polytechnics or university degrees were coded high. If a participant reported "No mother and father", the answer was coded missing. Appendix C shows how the chronic diseases were distributed by gender and parents' education.

#### 2.4. Statistical methods

Linear regression analyses were at first used to construct the models of the impact of chronic disease, gender, and parents' education on the first outcome: grade point average (GPA). Next, binary logistic regression analyses were performed for the second and third outcomes: ending up to non-academic secondary school and delayed start, including the same covariates but now also GPA as an explanatory variable. Odds ratios (OR) and their 95% confidence intervals were computed. Because of potential comorbidities of mental health problems and somatic chronic diseases, an adjustment for self-reported mental health problems was performed in all models.

The corresponding tables as performed by logistic models, are presented by average marginal effects analysis in Appendix D. The only difference was that in Table 3, disease with medication was not significant any more in Model 1. However, it was significant in Model 2 like in the Odds ratio analyses.

All statistical analyses were performed by IBM SPSS Statistics 28.0.1.0(142) except average marginal effects of the Appendix D were computed by margins library of R.

### 3. Results

In the 7th grade, 8.4% of students (N=753; N=332 girls; N=421 boys) reported having a chronic disease while in the 9th grade, the corresponding figure was 9.6% (N=708; N=309 girls; N=399 boys).

Students who had the disease with medication in either one of the grades had lower GPA than those who did not have the disease or had the disease but without medication (Table 1). The association persisted when the covariates (gender, parents' education) were added in the model (Model 2) and also when the variable indicating a mental health problem was added (Model 3). Boys had lower GPAs compared to girls, and students whose parents had high education or no mental health problem had higher GPA.

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Table 1. The association of chronic disease in the 7th grade (N=8960) and in the 9th grade (N=7394) with the grade point average (GPA<sup>a</sup>) in bivariate models (Model 1) and an adjusted model (Model 2). Linear regression analyses.

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7th grade						
Explanatory variable	Model 1 <sup>b</sup>		Model 2 <sup>c</sup>		Model 3 <sup>d</sup>	
	B (SE)	p value	B (SE)	p value	B (SE)	p value
Chronic disease						
Disease without medication (=yes)	-0.13 (0.08)	0.10	-0.09 (0.08)	0.21	-0.09 (0.08)	0.240
Disease with medication (=yes)	-0.17 (0.05)	<0.001	-0.14 (0.04)	0.001	-0.14 (0.04)	<0.001
Gender (=boy)	-0.47 (0.02)	<0.001	-0.46 (0.02)	<0.001	-0.46 (0.02)	<0.001
Parents' education (=high)	0.77 (0.02)	<0.001	0.77 (0.02)	<0.001	0.77 (0.02)	<0.001
Mental health problem (=yes)	-0.40 (0.13)	0.002			-0.49 (0.12)	<0.001
9th grade						
	Model 1 <sup>b</sup>		Model 2 <sup>c</sup>		Model 3 <sup>d</sup>	
	B (SE)	p value	B (SE)	p value	B (SE)	p value
Chronic disease						
Disease without medication (=yes)	-0.07 (0.08)	0.42	-0.03 (0.08)	0.70	-0.03 (0.08)	0.736
Disease with medication (=yes)	-0.18 (0.05)	<0.001	-0.14 (0.05)	0.003	-0.14 (0.05)	0.003
Gender (=boy)	-0.44 (0.02)	<0.001	-0.45 (0.02)	<0.001	-0.46 (0.02)	<0.001
Parents' education (=high)	0.74 (0.03)	<0.001	0.76 (0.03)	<0.001	0.75 (0.03)	<0.001
Mental health problem	-0.16 (0.08)	0.04			-0.23 (0.07)	0.002

a GPA is based on the final school marks from lower secondary school.

b Chronic disease, gender, parents' education and mental health problem each in a separate analysis.

c Adjusted for parents' education and gender.

d Adjusted for parents' education, gender, and mental health problem.

The statistically significant associations are marked in bold.

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Students who had the disease with medication in the 7th grade had higher odds of the non-academic track (Table 2, Model 1). When gender and parents' education were added in the model, the disease variable maintained its significance (Model 2). GPA was the most powerful predictor and the inclusion of it in the model caused the vanishing of the association (Model 3). The associations did not change when the mental health variable was added (Model 4).

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Table 2. The association of chronic disease in the 7th grade (N=8960) with ending up to the non-academic upper secondary school. Bivariate (Models 1) and adjusted logistic regression models (Models 2 and 3). Odds ratios (OR) and their 95% confidence intervals.

Explanatory variable	7th grade			
	Model 1 <sup>a</sup>	Model 2 <sup>b</sup>	Model 3 <sup>c</sup>	Model 4 <sup>d</sup>
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Chronic disease				
No	1.0	1.0	1.0	1.0
Disease without medication	1.2 (0.9-1.6)	1.1 (0.8-1.5)	1.1 (0.7-1.6)	1.1 (0.7-1.6)
Disease with medication	1.3 (1.1-1.5)	1.3 (1.05-1.5)	1.1 (0.9-1.4)	1.1 (0.9-1.4)
Gender				
Girl	1.0	1.0	1.0	1.0
Boy	1.7 (1.6-1.8)	1.8 (1.6-1.9)	1.2 (1.0-1.3)	1.2 (1.0-1.3)
Parents' education				
High	1.0	1.0	1.0	1.0
Middle/low	3.9 (3.6-4.3)	4.0 (3.6-4.4)	2.5 (2.3-2.8)	2.5 (2.3-2.8)
Grade point average				
High	1.0		1.0	1.0
Middle	12.6 (9.8-16.2)		10.5 (8.1-13.5)	10.4 (8.1-13.4)
Low	346 (256-468)		252 (186-342)	251 (185-340)
Mental health problem				
No	1.0			1.0
Yes	2.1 (1.4-3.4)			2.1 (1.2-3.6)

\* a Bivariate model. Each explanatory variable was analysed in a separate analysis

b Chronic disease, gender, and parents' education as explanatory variables in the model

c Chronic disease, gender, parents' education, and GPA as explanatory variables in the model

d Chronic disease, gender, parents' education, GPA, and mental health problem as explanatory variables in the model.

The statistically significant associations are marked in bold.

In the 9th grade, disease with medication was associated with ending up to non-academic track univariately but not in the adjusted models (Table 3). Low GPA was a powerful predictor of the non-academic track in all models. Also male gender, parents' low education, and mental health problem predicted the non-academic track in all models.

Table 3. The association of chronic disease in the 9th grade (N=7394) with ending up to the non-academic upper secondary school. Bivariate (Models 1) and adjusted logistic regression models (Models 2 and 3). Odds ratios (OR) and their 95% confidence intervals.

Explanatory variable	9th grade			
	Model 1 <sup>a</sup>	Model 2 <sup>b</sup>	Model 3 <sup>c</sup>	Model 4 <sup>d</sup>
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Chronic disease				
No	1.0	1.0	1.0	1.0
Disease without medication	1.1 (0.8-1.4)	1.0 (0.8-1.4)	1.0 (0.7-1.5)	1.0 (0.7-1.4)
Disease with medication	1.2 (1.04-1.5)	1.2 (1.0-1.4)	1.1 (0.8-1.3)	1.0 (0.8-1.3)
Gender				
Girl	1.0	1.0	1.0	1.0
Boy	1.7 (1.5-1.8)	1.8 (1.6-2.0)	1.2 (1.1-1.3)	1.2 (1.1-1.4)
Parents' education				
High	1.0	1.0	1.0	1.0

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Middle/low	3.9 (3.5-4.4)	4.1 (3.6-4.6)	2.6 (2.2-3.0)	2.6 (2.2-3.0)
Grade point average				
High	1.0		1.0	1.0
Middle	15.2 (11.2-20.5)		13.3 (9.8-18.0)	13.3 (9.8-18.0)
Low	346 (244-489)		273 (193-387)	273 (192-387)
Mental health problem				
No	1.0			1.0
Yes	1.6 (1.2-2.1)			1.7 (1.2-2.4)

\* a Bivariate model. Each explanatory variable was analysed in a separate analysis 213

b Chronic disease, gender, and parents' education as explanatory variables in the model 214

c Chronic disease, gender, parents' education, and GPA as explanatory variables in the model 215

d Chronic disease, gender, parents' education, GPA, and mental health problem as explanatory variables in the model. 216

The statistically significant associations are marked in bold. 217

The disease with medication in the 7th grade was significantly associated with the delayed start of upper secondary education also when adjustment was done for gender and parents' education, but no more after adjusting for GPA (Table 4). GPA was the most significant predictor and when added in the model (Model 3), boys' probability to start studies late was smaller compared to that of girls. Parents' education was a significant predictor in all models. Adjustment for a mental health problem did not change the associations (Model 4). 218-225

Table 4. The association of chronic disease in the 7th grade (N=8938) with the delayed start of upper secondary school. Bivariate (Model 1) and adjusted logistic regression models (Model 2 and 3). Odds ratios (OR) and their 95% confidence intervals. 226-228

7th grade				
Explanatory variable	Model 1 <sup>a</sup>	Model 2 <sup>b</sup>	Model 3 <sup>c</sup>	Model 4 <sup>d</sup>
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Chronic disease				
No	1.0	1.0	1.0	1.0
Disease without medication	0.8 (0.4-1.6)	0.8 (0.4-1.6)	0.8 (0.4-1.5)	0.7 (0.4-1.5)
Disease with medication	1.4 (1.0-1.9)	1.4 (1.0-2.0)	1.3 (1.0-1.8)	1.3 (1.0-1.8)
Gender				
Girl	1.0	1.0	1.0	1.0
Boy	1.0 (0.8-1.2)	1.0 (0.8-1.1)	0.7 (0.6-0.9)	0.7 (0.6-0.9)
Parents' education				
High	1.0	1.0	1.0	1.0
Middle/low	2.0 (1.7-2.4)	2.0 (1.7-2.4)	1.3 (1.1-1.5)	1.3 (1.1-1.5)
Grade point average				
High	1.0		1.0	1.0
Middle	4.4 (2.9-6.9)		4.4 (2.8-6.9)	4.4 (2.8-6.9)
Low	14.6 (9.4-22.7)		14.4 (9.1-22.6)	14.3 (9.1-22.4)
Mental health problem				
No	1.0			1.0
Yes	2.1 (1.1-4.3)			1.8 (0.9-3.7)

a Bivariate model. Each explanatory variable was analysed in a separate analysis 229

b Chronic disease, gender, and parents' education as explanatory variables in the model 230

c Chronic disease, gender, parents' education, and GPA as explanatory variables in the model 231

d Chronic disease, gender, parents' education, GPA, and mental health problem as explanatory variables in the model.  
The statistically significant associations are marked in bold.

In the 9th grade, the disease was not associated with the delayed start, and gender was associated only in Model 3 (Table 5). GPA was significant in both the bivariate model and in Model 3. Parents' education was statistically significant in the bivariate analysis (Model 1) and in Model 2, but not when GPA was added (Model 3). Adding the variable of a mental health problem did not change the associations (Model 4).

We conducted sensitivity analyses, in which we had each disease separately in the regression models (Appendices A and B). The association of each disease with the outcome variables was of similar direction as that of the chronic disease. The associations with both GPA and ending up to a non-academic upper secondary school were stronger for epilepsy than associations for the two other diseases.



Table 5. The association of chronic disease in the 9th grade (N=7384) with the delayed start of upper secondary school. Bivariate (Model 1) and adjusted logistic regression models (Model 2 and 3). Odds ratios (OR) and their 95% confidence intervals.

Explanatory variable	9th grade			
	Model 1 <sup>a</sup>	Model 2 <sup>b</sup>	Model 3 <sup>c</sup>	Model 4 <sup>d</sup>
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Chronic disease				
No	1.0	1.0	1.0	1.0
Disease without medication	0.8 (0.4-1.6)	0.8 (0.4-1.6)	0.8 (0.4-1.6)	0.8 (0.4-1.6)
Disease with medication	1.3 (0.9-1.8)	1.2 (0.9-1.8)	1.2 (0.8-1.7)	1.2 (0.8-1.7)
Gender				
Girl	1.0	1.0	1.0	1.0
Boy	1.1 (0.9 - 1.3)	1.1 (0.9-1.3)	0.8 (0.7-1.0)	0.8 (0.7-1.0)
Parents' education				
High	1.0	1.0	1.0	1.0
Middle/low	1.7 (1.4-2.1)	1.7 (1.4-2.1)	1.0 (0.8-1.3)	1.0 (0.8-1.3)
Grade point average				
High	1.0		1.0	1.0
Middle	5.1 (3.0-8.6)		5.2 (3.1-8.9)	5.2 (3.1-8.8)
Low	17.8 (10.5-30.2)		18.6 (10.8-32.0)	18.4 (10.7-31.6)
Mental health problem				
No	1.0			1.0
Yes	1.9 (1.2-3.1)			1.7 (1.0-2.8)

a Bivariate model. Each explanatory variable was analysed in a separate analysis

b Chronic disease, gender and parents' education as explanatory variables in the model

c Chronic disease, gender, parents' education and GPA as explanatory variables in the model

d Chronic disease, gender, parents' education, GPA and mental health problem as explanatory variables in the model.

The statistically significant associations are marked in bold.

#### 4. Discussion

School performance (GPA) was slightly lower among students with the chronic disease needing medication compared to those who did not have the disease or whose disease was without medication. Those who used medication had slightly higher odds of ending up to the non-academic track, but this association disappeared when adjustment was done for GPA in the graduation report. The delayed start of upper secondary school was associated with chronic disease at the 7th grade but not at the 9th grade. Low GPA was the most powerful predictor in the models. Male gender, low parents' education and mental health problem predicted all three outcomes. The associations were stronger for epilepsy than for diabetes or asthma.

Our findings support earlier studies where chronic conditions [14,16–18,27] or special needs [16] have been associated with indicators of poorer educational attainments. Chronic health conditions studied most comprise asthma, epilepsy, cancer, juvenile arthritis, kidney disease, diabetes, gastrointestinal diseases, or heart conditions in different combinations of diseases [14–16,28,29].

The mechanisms through which an illness influences school achievement can be direct or indirect. Knight and Perfect (2019) [30] demonstrated a direct effect in their study; diabetic adolescents whose glucose levels were frequently out of the target range had a higher risk for performing below their true academic potential. An Australian study showed that children with type 1 diabetes did not significantly differ from their peers in the studied indicators of school performance, but poorer glycaemic control was associated with a lower test score [31]. Martinez and Ercikan (2009) [32] showed that chronically ill children performed less well in a standard test of mathematical skills and problem solving. Many chronic conditions directly impact neurocognitive functioning with understandable harm for learning and achievement [33,34].

The effect of the chronic condition on educational attainment may also be indirect. Chronically ill adolescents may have lower educational aspirations and expectations, which affect the educational career [18,35]. Further, social exclusion, absences from school [12,31], emotional distress and mental health problems related to chronic conditions [33,34] may be mediating factors. Chronic conditions are known to increase the risk of mental health problems [34]. The reciprocal association between psychological symptoms and negative school experiences often have a negative impact on achievement, too [23,25,27,36]. People with mental health problems often face discrimination and may be stigmatized – by other people, but also by the person him- or herself – and this may have a further negative impact on self-concept and faith to personal abilities [37].

Our associations observed for epilepsy were stronger than for the other diseases. This suggests that adolescents with epilepsy may have severe problems in their educational careers. Childhood- and adolescent-onset of epilepsy has been found to predict a low socioeconomic position, educational level included [38]. One possible mechanism is that the disease may lead to becoming labelled as a deviant or less capable person. This may reduce resources needed in making educational decisions, and more so, if important adults, for example, professionals giving career advice have prejudices about the young persons' abilities and chances of success [39].

The strong role played by GPA for the selection of the educational track and delayed start was obvious because it is the most important selection criterium for a study place. The vanishing association between the track and the disease at the 7th grade when adjusting for GPA shows how the disease influences academic performance and how GPA works as a mediator between the chronic disease and association. This has been suggested by some other studies as well [15,27].

Our study confirmed earlier findings on boys' lower school performance compared to girls and the significance of parents' education for children's school attainment [9,40]. The attitudes of Finnish students to reading, especially of boys, have become more negative according to the PISA study [9]. High-educated parents are more often able to support their children's cognitive development [41,42], as well as use their material, cultural and social compensatory resources to promote their children's learning and educational careers.

The chronic illness needing medication was a contributing factor in dividing adolescents into different educational tracks but did not influence the smoothness of the transition from lower to upper secondary education. The effects were, however, small. The Finnish advanced system of school health service and student welfare support [21], as well as the means to help pupils with learning difficulties [22] have likely contributed to the small effect. These may also have helped students cope with disease and medications at school and better understand the limitations of the disease. Our understanding of the role of chronic diseases in students' learning and attitudes to education is still scarce. Disease-specific studies would illuminate more specifically the phenomena. Further, research from other countries may help to understand the role of health and support services in minimizing the negative influences of the diseases. Parents' education was used here as a socio-economic indicator of students' family background. In future research, a

wider set of indicators would be useful to describe adolescents' varying life contexts, e.g., the framework of the socioecological model [43].

### 5. Conclusions

Our results showed that in adolescence chronic conditions that need medication may negatively affect students' school performance. Despite the quite modest associations, a chronic condition may act as a selection factor in the transition from lower to upper secondary education. Further research is needed about how single diseases and their comorbidities affect educational outcomes, and if the influence of chronic diseases varies according to educational system, arrangement of learning support and quality of adolescent health care. A chronic condition in adolescence, especially when needing medication may be one of the health selection mechanisms causing health inequality in adulthood [44]. Improving support for learning and quality of school welfare services are likely to help students with a chronic condition to achieve their full academic potential.

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**Institutional Review Board Statement:** The study was conducted in accordance with the Declaration of Helsinki, and approved by the Ethics Committee of the Finnish National Institute of Health and Welfare (protocol code and the date of approval for the 2011 survey is 27.5.2011 and for the 2014 survey 9.4.2014).

**Informed Consent Statement:** Informed consent was obtained from all subjects involved in the study.

**Data Availability Statement:** The data presented in this study may be available upon a well-argued, detailed research plan from a non-profit university or research institution on request from Professor Arja Rimpelä, Tampere University and Professor Risto Hotulainen, University of Helsinki. All metadata are in Finnish.

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### Appendix A

Table A1. The associations between individual chronic diseases with the grade point average (GPA) adjusting for gender, 7th and 9th grade. Linear regression analyses.

Explanatory variable	7th grade		9th grade		
	B (SE)	<i>p</i>	B (SE)	<i>p</i>	
Chronic disease <sup>a</sup>					
Asthma (N=608)	-0.12 (0.05)	0.010	Asthma (N = 551)	-0.06 (0.05)	0.21
Diabetes (N=92)	-0.07 (0.11)	0.55	Diabetes (N = 88)	-0.01 (0.11)	0.94
Epilepsy (N=37)	-0.43 (0.18)	0.015	Epilepsy (N = 42)	-0.67 (0.16)	<0.001

<sup>a</sup> For each disease, the reference category does not include persons who have any other of these three diseases. The participants with the investigated disease in each analysis may have another disease in addition to the investigated one.

Appendix B

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Table A2. The associations between individual chronic diseases with ending up to a non-academic upper secondary school, 7th and 9th grade. Bivariate logistic regression model. Odds ratios (OR) and their 95% confidence intervals (95% CI).

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Explanatory variable	7th grade Chronic disease			9th grade Chronic disease		
	Asthma	Diabetes	Epilepsy	Asthma	Diabetes	Epilepsy
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
	N = 8839	N = 8323	N = 8268	N = 7275	N = 6812	N = 6766
Chronic disease						
No	1.0	1.0	1.0	1.0	1.0	1.0
Yes	1.1 (0.9-1.3)	1.3 (0.9-2.0)	2.8 (1.4-5.5)	1.0 (0.8-1.2)	1.2 (0.7-1.8)	3.7 (1.9-7.0)
Gender						
Girl	1.0	1.0	1.0	1.0	1.0	1.0
Boy	1.7 (1.5-1.8)	1.7 (1.6-1.9)	1.7 (1.6-1.9)	1.7 (1.5-1.8)	1.6 (1.5-1.8)	1.6 (1.5-1.8)

a For each disease, the reference category does not include persons who have any other of these three diseases. The participants with the investigated disease in each analysis may have another disease in addition to the investigated one.

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Appendix C.

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Table A3. Distribution of chronic disease by gender and parents' education, 7th grade. Distributions do not differ significantly by disease. Pearson's chi-square test for boys is  $\chi^2(2, N=4425) = 1.5, p=0.48$  and for girls  $\chi^2(2, N=4535) = 2.5, p=0.29$ .

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Chronic disease	Boys Parents' education				Girls Parents' education			
	Low		High		Low		High	
	N	%	N	%	N	%	N	%
1. No disease	2. 1	3. 9	4. 2		6. 1	7. 93.	8. 27	9. 92.
	4	0	5	5. 90.	4	0	11	5
	4	.	5	6	9			
	8	2	6		2			
Disease without medication	34	2.1	70	2.5	32	2.0	47	1.6
Disease with medication	123	7.7	194	6.9	80	5.0	173	5.9
Total	1605	100.0	2820	100.0	1604	100.0	2931	100.0

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Appendix D

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Table A4. Ending up to the non-academic upper secondary school: the analyses of the logistic models of Table 2 presented as average marginal effects. Standard deviations in parentheses.

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Explanatory variable	7th grade (N = 8960)			
	Model 1 <sup>a</sup>	Model 2 <sup>b</sup>	Model 3 <sup>c</sup>	Model 4 <sup>d</sup>
Chronic disease				
No disease = reference				
Disease without medication	0.035 (0.037)	0.025 (0.034)	0.010 (0.029)	0.009 (0.029)
Disease with medication	0.057 (0.021)	0.049 (0.020)	0.018 (0.017)	0.018 (0.017)
Gender				

Girl = reference				
Boy	0.12 (0.010)	0.12 (0.0094)	0.021 (0.0080)	0.021 (0.0080)
Parents' education				
High=reference				
Middle/low	0.29 (0.0079)	0.29 (0.0079)	0.13 (0.0076)	0.13 (0.0076)
Grade point average				
High = reference				
Middle	0.28 (0.0077)		0.27 (0.0083)	0.27 (0.0083)
Low	0.89 (0.0075)		0.86 (0.0094)	0.86 (0.0094)
Mental health problem				
No = reference				
Yes	0.18 (0.054)			0.10 (0.041)

\* a Bivariate model. Each explanatory variable was analysed in a separate analysis

b Chronic disease, gender, and parents' education as explanatory variables in the model

c Chronic disease, gender, parents' education, and GPA as explanatory variables in the model

d Chronic disease, gender, parents' education, GPA, and mental health problem as explanatory variables in the model.

The statistically significant associations are marked in bold.

Table A5. Ending up to the non-academic upper secondary school: the analyses of the logistic models of Table 3 presented as average marginal effects. Standard deviations in parentheses.

9th grade (N = 7394)				
Explanatory variable	Model 1 <sup>a</sup>	Model 2 <sup>b</sup>	Model 3 <sup>c</sup>	Model 4 <sup>d</sup>
Chronic disease				
No disease = reference				
Disease without medication	0.015 (0.036)	0.0072 (0.034)	-0.001 (0.028)	-0.0037 (0.028)
Disease with medication	0.051 (0.022)	0.037 (0.021)	0.0071 (0.017)	0.0068 (0.017)
Gender				
Girl = reference				
Boy	0.11 (0.011)	0.12 (0.010)	0.025 (0.0089)	0.027 (0.0089)
Parents' education				
High=reference				
Middle/low	0.29 (0.011)	0.30 (0.011)	0.14 (0.010)	0.14 (0.010)
Grade point average				
High = reference				
Middle	0.28 (0.0081)		0.27 (0.0084)	0.27 (0.0085)
Low	0.88 (0.0088)		0.86 (0.010)	0.86 (0.010)
Mental health problem				
No = reference				
Yes	0.11 (0.033)			0.075 (0.026)

\* a Bivariate model. Each explanatory variable was analysed in a separate analysis

b Chronic disease, gender, and parents' education as explanatory variables in the model

c Chronic disease, gender, parents' education, and GPA as explanatory variables in the model

d Chronic disease, gender, parents' education, GPA, and mental health problem as explanatory variables in the model.

The statistically significant associations are marked in bold.

Table A6. The delayed start of upper-secondary school: the analyses of the logistic models of Table 4 presented as average marginal effects. Standard deviations in parentheses.

7th grade (N = 8938)				
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Explanatory variable	Model 1 <sup>a</sup>	Model 2 <sup>b</sup>	Model 3 <sup>c</sup>	Model 4 <sup>d</sup>
<b>Chronic disease</b>				
No disease = reference				
Disease without medication	-0.010 (0.016)	-0.010 (0.016)	-0.014 (0.015)	-0.014 (0.015)
Disease with medication	0.023 (0.012)	0.024 (0.012)	0.018 (0.011)	0.018 (0.011)
<b>Gender</b>				
Girl = reference				
Boy	-0.0016 (0.0051)	-0.0023 (0.0050)	-0.018 (0.0051)	-0.018 (0.0051)
<b>Parents' education</b>				
High=reference				
Middle/low	0.040 (0.0052)	0.040 (0.0052)	0.013 (0.0052)	0.014 (0.0052)
<b>Grade point average</b>				
High = reference				
Middle	0.038 (0.0039)		0.0380 (0.0039)	0.038 (0.0039)
Low	0.13 (0.0087)		0.13 (0.0094)	0.13 (0.0094)
<b>Mental health problem</b>				
No = reference				
Yes	0.043 (0.021)			0.032 (0.020)

a Bivariate model. Each explanatory variable was analysed in a separate analysis

b Chronic disease, gender, and parents' education as explanatory variables in the model

c Chronic disease, gender, parents' education, and GPA as explanatory variables in the model

d Chronic disease, gender, parents' education, GPA, and mental health problem as explanatory variables in the model.

The statistically significant associations are marked in bold.

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Table A7. The delayed start of upper-secondary school: the analyses of the logistic models of Table 5 presented as average marginal effects. Standard deviations in parentheses.

Explanatory variable	9th grade (N=7384)			
	Model 1 <sup>a</sup>	Model 2 <sup>b</sup>	Model 3 <sup>c</sup>	Model 4 <sup>d</sup>
<b>Chronic disease</b>				
No disease = reference				
Disease without medication	-0.011 (0.015)	-0.011 (0.012)	-0.012 (0.015)	-0.012 (0.015)
Disease with medication	0.014 (0.011)	0.013 (0.011)	0.0077 (0.010)	0.0077 (0.010)
<b>Gender</b>				
Girl = reference				
Boy	0.0043 (0.0053)	0.0048 (0.0053)	-0.011 (0.0053)	-0.0099 (0.0054)
<b>Parents' education</b>				
High=reference				
Middle/low	0.027 (0.0060)	0.027 (0.0060)	0.0019 (0.0060)	0.0020 (0.0060)
<b>Grade point average</b>				
High = reference				
Middle	0.036 (0.0039)		0.036 (0.0039)	0.036 (0.0039)
Low	0.13 (0.0098)		0.14 (0.011)	0.14 (0.011)
<b>Mental health problem</b>				
No = reference				
Yes	0.034 (0.013)			0.026 (0.013)

a Bivariate model. Each explanatory variable was analysed in a separate analysis 401  
 b Chronic disease, gender, and parents' education as explanatory variables in the model 402  
 c Chronic disease, gender, parents' education, and GPA as explanatory variables in the model 403  
 d Chronic disease, gender, parents' education, GPA, and mental health problem as explanatory variables in the model. 404  
 The statistically significant associations are marked in bold. 405  
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