The impact of the COVID-19 school closure on adolescents' use of mental healthcare services in Sweden

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Abstract

School closures used to contain the COVID-19 pandemic may have negative impact on students' mental health but credible evidence is scares. Sweden moved upper-secondary students to remote learning but, as the only country in the OECD, kept schools at lower levers open throughout the pandemic. Using nationwide register data, we study the impact of moving to remote teaching on upper-secondary students' contacts with mental health care services. We study the impact on all contacts with hospitals and specialist psychiatric care due to mental and behavioral disorder, and all prescriptions for antidepressants, insomnia, and ADHD drugs. Compared to expected rates, the use of mental healthcare services among upper-secondary students fell by -4.36 %, largely due to a reduction in depression and anxiety-related diagnoses and antidepressants. The decrease is concentrated to students who were not in contact with mental healthcare services earlier in the academic year. Auxiliary results show the reduction is not likely due to limited access to care. The decrease persisted through July 2020-March 2021 when upper-secondary resumed some in-person teaching at school. Moreover, the largest relative reduction is seen for unplanned care and care at emergency units. We would expect limited access to specialist psychiatric care to result in an increase in visits to emergency facilities. There is also no differential change between upper- and lower secondary students in visits to healthcare for health issues unrelated to mental health and covid-19. In a setting with no strict lockdown, moving to remote teaching for a limited period did not worsen mental health among students in upper-secondary schools.

Keywords: COVID-19, mental healthcare, school closure, differences-in-differences
JEL: I10; I18; I28

Introduction

School closures have been one of the most widely used disease containment measures during the COVID-19 pandemic. As education for billions of children has been disrupted there are raising concerns about the consequences of school closures on learning and mental health of children and adolescents (UNESCO 2021). Isolating the consequences of school closures on mental health is challenging as most countries closed all schools at the onset of the pandemic and at the same time introduced a number of non-pharmaceutical interventions (NPIs). In contrast to all other OECD countries, Sweden only moved upper-secondary students to remote instruction, while schools for younger students remained open (OECD 2021a). This partial school closure allows for a comparison of adolescents differently exposed to school closures but otherwise facing similar conditions. Using Swedish population wide register data, we employ a difference-in-difference strategy to study differences in the use of mental healthcare services between upper (age 17-19) and lower (age 14-16) secondary students before and during the pandemic. Under the assumption that the use of mental healthcare services would have developed similarly for the two groups if upper-secondary schools had not closed, these estimates can be interpreted as causal.

According to own literature searches and a recent systematic review (Viner et al. 2022), no previous study has been able to separate the impact of school closures on mental health or mental healthcare use from broader lockdown measures. There are, however, several studies on the development of mental healthcare use during the pandemic. For the initial phase of the pandemic, studies show large decreases in the use of healthcare for self-harm, anxiety, depression, and for prescriptions of psychiatric drugs among adolescents (Jollant et al. 2021; Carr et al. 2021; Evensen et al. 2021; Ougrin 2020). After the initial phase, healthcare use seems to have reverted back to earlier levels in England (Carr et al. 2021) or possibly even higher levels in Norway (Evensen et al. 2021). A similar pattern is found for suicide in Japan (Tanaka and Okamoto 2021). The initial reduction in mental healthcare use is plausibly explained by limited access, as the healthcare sector was urged to reduce face-to-face patient contacts and patients being hesitant to seek care. By comparing students in upper-secondary schools with students in lower-secondary schools during the same time-periods, we effectively hold constant factors such as access to and the capacity of the healthcare system, the consequences of other NPIs, as well as other direct and indirect effects of the pandemic.

The main outcome in this study is the incidence of psychiatric care among adolescents, defined as either a psychiatric diagnoses from a healthcare contact at hospitals or specialist psychiatric care facilities, or the prescription of a psychiatric drug. The main study period is the period of school closure, April-June 2020. An important question is if changes in healthcare use are due to changes in access or changes in actual needs. We address this by studying the use of different types of care and how mental healthcare use develops until March 2021. We further investigate whether responses depend on sex, family socioeconomic status and whether the student had contacts with mental health care services earlier in the academic year.

Methods

School closures and other disease containment measures in Sweden

March 18, 2020 upper-secondary schools moved to remote instruction while schools for younger students remained open until the summer break in mid-June. Around the same date, Public Health Authorities introduced several other containment measures that were nation-wide

and affected everyone. Preventive measures in schools that remained open were mild and most school-related activities operated largely as usual.

After the summer break, upper-secondary schools re-opened but could move to remote instruction after consultation with local infection officers. In general, schools mainly relied on in-person teaching until late October when infection rates increased. On December 7, all upper-secondary schools closed. On January 24 2021, upper-secondary schools reassumed some in-person teaching but student presence in schools was restricted throughout the spring. Lower-secondary schools remained open throughout the spring and fall of 2020. From January 2021, lower-secondary schools were allowed to use remote instruction if local conditions so required. See details in the supplementary materials.

We primarily study outcomes in April-June 2020 when upper-secondary schools were fully closed and lower-secondary schools open. Since lower-secondary students attended school essentially as normal, comparing their use of mental healthcare services to that of upper-secondary students gives a credible estimate of the impact of school closures. To track longer-term outcomes, we follow the students exposed to the initial period of school closures until March 2021. Mental health in this later period could be affected both by lagging consequences of the initial school closure and by the partial closure during the academic year 20/21. Moreover, during the later period, final year upper-secondary students left school while final year lower-secondary students moved to upper-secondary school. Final year students at both levels thus received a mixed exposure during the follow-up period.

Data and study population

The study population consists of all upper- and lower-secondary students in the academic years 2015/16 to 2019/20. The database used is part of the research program "Covid-19 in Sweden: Infection tracing, control and effects on individuals and society" at Stockholm University. Personal identifiers allow for linkages between registries and families. Information on school grade, sex, age, and parental characteristics are from registers held by Statistics Sweden. Information on healthcare use are from registers held by National Board of Health and Welfare (NBHW). We identify all healthcare contacts at hospitals or specialist psychiatric care facilities with diagnoses within chapter F in the ICD10 classification system - Mental, behavioral and neurodevelopmental disorder - and prescriptions of drugs for insomnia (ATC-code N05), attention deficit hyperactivity disorder (ADHD) (ATC-code N06B and C02AC02), and antidepressants (ATC-Code N06A). The main outcome variable is an indicator taking the value one if the student had either a chapter F diagnosis or was prescribed a psychiatric drug as per above during each respective period. The data does not include information on contacts with primary healthcare. However, the prescription data include information on all drugs prescribed in Sweden, including primary care. We also study different diagnoses separately, if the contacts in specialist care were planned or not, and if diagnoses were from emergency units and psychiatric emergency units. As a test of whether general access to healthcare decreased, we study contacts with healthcare deemed unrelated to mental health and COVID-19. This measure includes all contacts with healthcare due to neoplasm (ICD10 C, D0-D4), diseases of skin and subcutaneous tissue (ICD10 L), endocrine, nutritional and metabolic diseases (ICD10 E) and diseases of the circulatory system (ICD10 I). See supplementary materials for data sources, detailed descriptions of variables and summary statistics (Table S1).

Ethical approval for the study was obtained from the Swedish Ethical Review Authority application 2020-06492.

Statistical analysis

In the main analysis, we analyze the change in contact with mental health care services April-June 2020 compared to the same period in 2019. We also estimate the corresponding change compared to each year 2016-2018. Thus, we estimate the following difference-in-difference models using linear regression (OLS):

$$y_{ist} = \gamma_s + \delta_t + \sum_{\tau=2016,\tau\neq2019}^{2020} \beta_\tau D_{s\tau} + \boldsymbol{X}_{ist} + \varepsilon_{it}$$

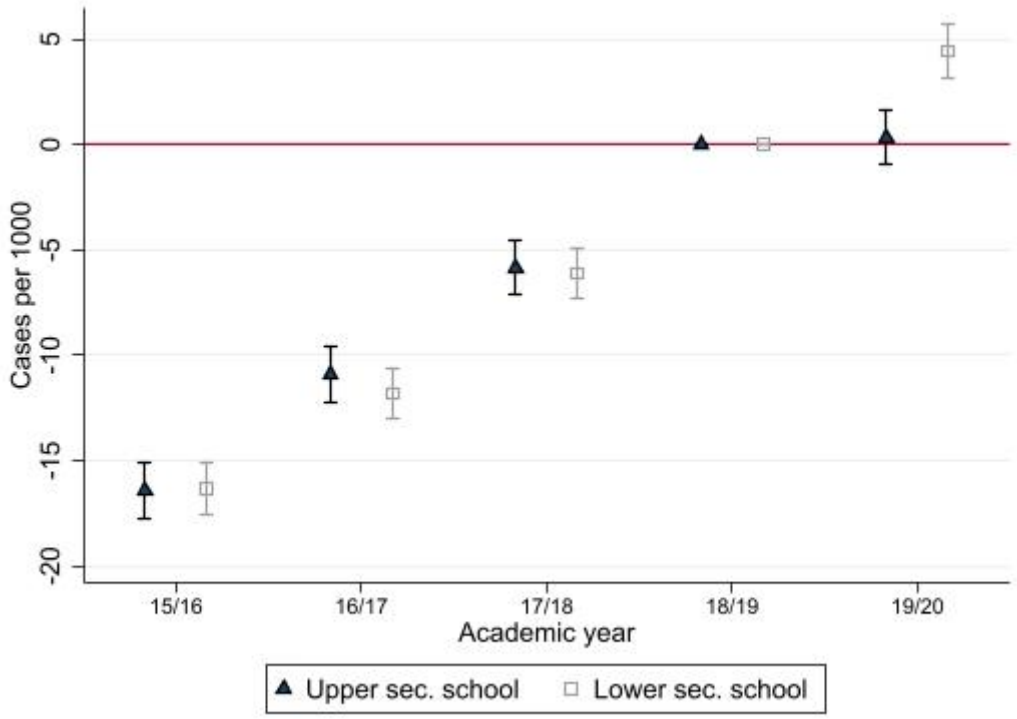
The main outcome y_{ist} is an indicator variable taking the value one if individual *i* was in contact with mental healthcare services or received a drug prescription for the causes described in the data section. γ_s is an indicator for whether the student attended upper-secondary school and *t* refers to the academic year. The estimates of β_τ are the differences between upper- and lower-secondary students for each academic year, compared to the reference year (2019) prior to the pandemic. In order to adjust for potential compositional changes in the student population, a vector **X** of detailed individual- and parent characteristics is included (see supplement from details).

We provide a sub-group analysis by splitting the sample by student sex, parental income (at least one parent in the 4th income quartile), and if the student was in contact with mental healthcare services earlier in the academic year. To assess if access to healthcare matters, we provide separate analyses for diagnoses from healthcare visits and drug prescriptions, planned or unplanned care visits, and diagnoses from emergency units. To account for the longer-term impact of the initial school closures, the model is estimated when the outcome is measured in the period July 2020-March 2021. We also estimate a model where we compare the outcome for students in each school grade (grade 8 being the reference group) before and after schools closed (see supplementary materials for details on these specifications).

Results

The use of mental health care services among adolescents has increased for several years in Sweden (NBHW, 2019). These trends are illustrated in Figure 1 for the April-June-period among upper- and lower-secondary students. The figure displays the estimates from a linear regression of contacts with mental health services on year fixed effects for upper- respectively lower-secondary students. Before the pandemic, use of mental health care services increased in tandem for lower- and upper-secondary students with about 5 cases per 1000 each year. In 2020, when upper-secondary schools were closed, contacts with mental healthcare services among lower-secondary students increased at the same rate as earlier years, whereas contacts among upper-secondary students remained at the 2019 level. As lower-secondary students continued to follow their pre-pandemic trend, these results suggest there was no general drop in contacts with mental health care services.

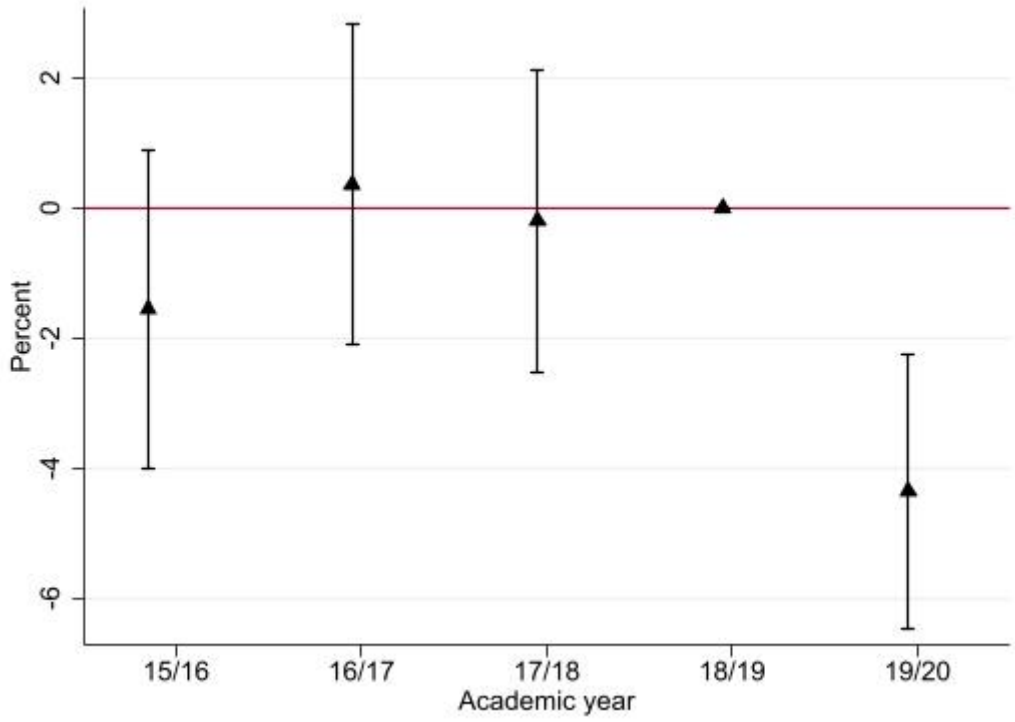
Figure 1. Trends in use of mental healthcare services, April-June



Note: Use of mental healthcare services during April-June each respective academic year. Estimates from separate linear regressions for upper-secondary respectively lower-secondary students. 95% CI indicated.

To test whether upper-secondary students reduced their use of mental health care services we estimate the difference-in-difference model specified above. Relative to the expected rate, upper-secondary students reduced their contacts with 3.71 [CI95 -5.51 to -1.91] cases per 1000 in the period April-June 2020 (supplement Table S2). This corresponds to a 4.36% [CI95 -6.47 to -2.25] decrease relative to the mean for upper-secondary students in 2019. Figure 2 shows the difference-in-difference estimates for each year rescaled to changes in percent. As can be seen in the figure contacts with mental healthcare services followed a similar trend for the two groups in the years preceding the pandemic. Diverging long-term trends can therefore not account for the difference between upper- and lower-secondary students that is estimated for 2020. Furthermore, the estimates are not affected by adjusting for background characteristics suggesting the change in 2020 is not due to compositional changes in the student population (supplementary materials Table S2).

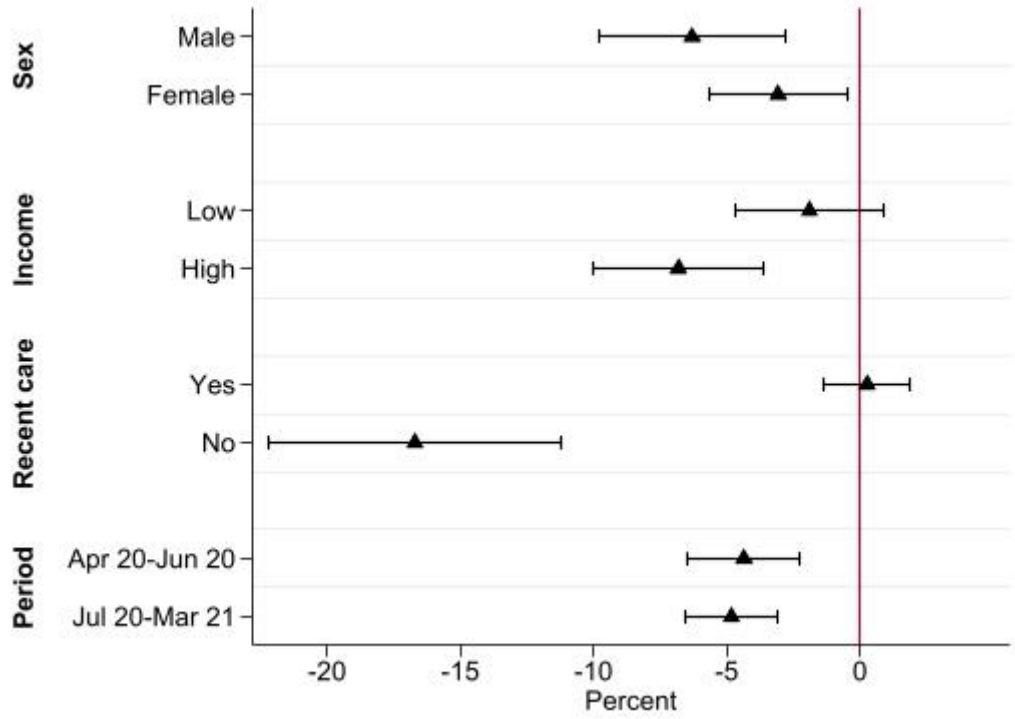
Figure 2 Mental healthcare use among upper-secondary students, April-June



Note: Difference-in-difference estimates from linear regression rescaled to percent. Lower-secondary students act as the control group for upper-secondary students. Outcomes are measured during April-June each academic year and 2018/19 is the reference period. 95% CI indicated.

shows difference-in-difference estimates for sub-populations, scaled to changes in percent for 2020 relative to 2019 (see supplementary materials Table S2). The negative estimate is larger for males, -6.30% [CI95 -9.82 to -2.77], than for females, -3.07% [CI95 -5.67 to -0.48]. The decrease is larger among students from higher income families, -6.81% [CI95 -10.03 to - 3.60], than lower income families, -1.89% [CI95 -4.69 to 0.90]. Splitting the population by use of mental healthcare earlier in the academic year shows that students who had not received such care account for the entire reduction, -16.70% [CI95 -22.20 to -11.20]. Among student with prior contacts, there is no change, 0.27% [CI95 -1.33 to 1-87]. Finally, relative to the expected rate, the reduction in the use of mental healthcare among students exposed to the initial school closure was of similar magnitude during April-June 2020, -4.36% [CI95 -6.47 to -2-25], and July 2020-March 2021, -4.82% [CI95 -6.53 to -3.11]. Supplement Figure S1 shows that healthcare use among lower-secondary students follows the trend for both the April-June and July-March periods, while use among upper-secondary is below trend for both periods. There is thus no indication of a built-up demand due to unmet needs.

Figure 3 Estimates for sub-groups and time-periods



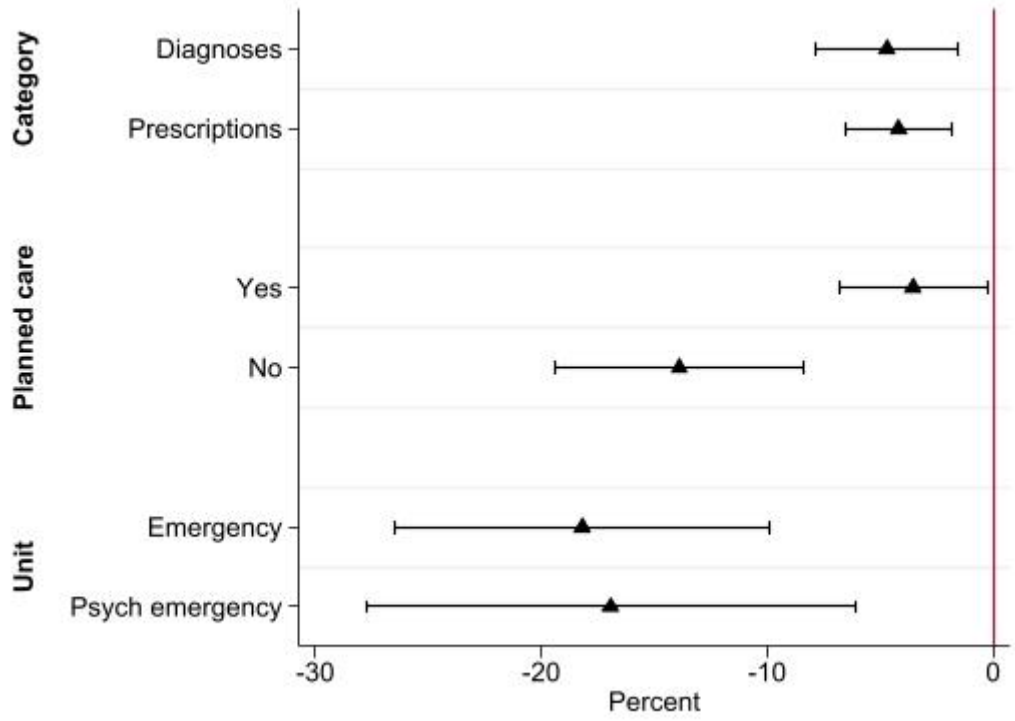
Note: Difference-in-difference estimates by sex, parental income, and if the person had contact with health care earlier during the academic year. Outcomes are measured during April-June, except when indicated to refer to the July-March period. Estimates from separate linear regressions are rescaled to percent. 95% CI indicated.

Table S3 in the supplement shows difference-in-difference estimates for sub-diagnoses and psychiatric drugs. The results indicate reductions mainly for depression and anxiety. Healthcare contacts with diagnoses for depression and anxiety are reduced by - 7.37% [CI95 - 11.65 to - 3.08] and prescriptions of antidepressants by -4.70% [CI95 -7.62 to - 1.77]. For diagnoses likely unrelated to mental health and COVID-19, we find a small and statistically insignificant estimate, 0.22% [CI95 -3.86 to 4.29]. This indicates that there is no reduction in the general access to healthcare, specific to upper-secondary students.

One shortcoming of the analysis is that we lack data on primary care visits. However, data on prescribed psychiatric drugs cover all providers, including primary care. Supplementary Figure S2 and*Figure S3* show that the deviation from the pre-pandemic trend between upper- and lower-secondary students is of similar magnitude for diagnoses from healthcare visits and prescription drugs. The corresponding difference-in-difference estimates shown in Figure 4 are -4.70% [CI95 -7.87 to -0.62] for diagnoses and -4.18% [CI95 -6.49 to -1.87] for prescription drugs (supplementary Table S4). Another concern is that school closures might have reduced upper-secondary students' access to psychiatric care through the schools' healthcare facilities. This would then imply that the estimated reduction might be due to reduced access. If access through normal channels is reduced, this would plausibly shift upper-secondary students (relative to lower-secondary students) towards unplanned care and emergency care facilities. However, difference-in-difference estimates in Figure 4 show that the relative decrease among upper-secondary students is substantially larger for unplanned, - 13.88% [CI95 -19.35 to -9.92] than for planned care, - 3.56% [CI95 -6.84 to -0.27] during the period when schools were fully closed. In particular, there is a large relative decrease in psychiatric diagnoses from contacts with emergency - 18.19% [CI95 -26.45 to -9.92] or psychiatric emergency units among upper-

secondary students - 16.92% [CI95 -27.73 to -6.12]. These results are inconsistent with the patterns of substitution between providers that we would expect if reduced access through normal facilities lies behind the main results.

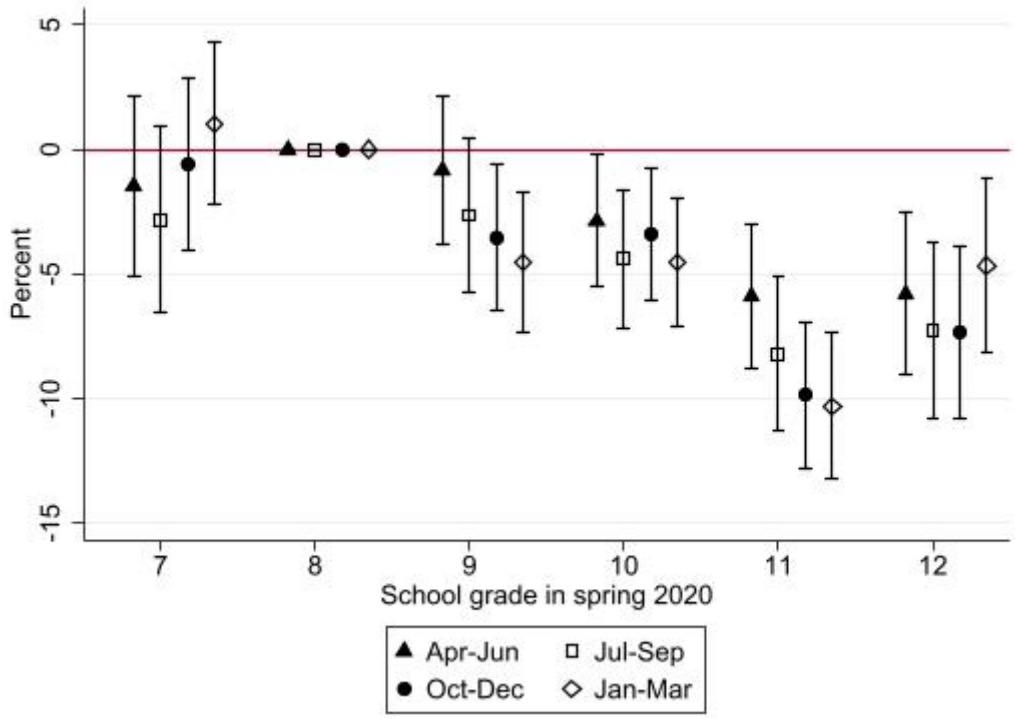
Figure 4 Estimates by types of care, April-June



Note: Difference-in-difference estimates from separate linear regressions rescaled to percent. Outcomes are measured during April-June. 95% CI indicated.

Next, we analyze if mental healthcare use changed differently depending on the students' school grade in the spring of 2020 (see the regression model in supplementary materials). The triangles in Figure 5 show difference-in-difference estimates, rescaled to percent, of the main outcome during April-June 2020, for each school grade relative to grade 8 (supplementary materials Table S5). For grades 7 and 9, the estimates are small and statistically insignificant, which is expected since lower-secondary schools mainly continued operations as normal. For grade 10, the first year of upper-secondary school, there is a reduction in healthcare contacts by -2.88% [CI95 -5.53 to -0.23]. The negative effect is larger for grades 11 (- 5.89% [CI95 -8.79 to -2.98] and 12 (-5.80% [CI95 -9.07 to -2.52]). Figure 5 also displays estimates for the periods July-September 2020, October-December 2020, and January-March 2021. Most grade 9-students transited to upper-secondary school in August 2020, whereas most grade 12-students graduated and left school. Relative to expected rates, healthcare contacts among grade 9-students decreased upon entering upper-secondary school in the fall of 2021. Rates among grade 12 students remained lower than expected throughout the fall and spring after graduation. Among students in grade 10, the rate of healthcare contacts remain lower than expected throughout the period of investigation. For students in grade 11, there is an initial drop and then a continued decrease until March 2021.

Figure 5 Mental healthcare use during the pandemic among students in school grades 7-12



Note: Difference-in-difference estimates from linear regression rescaled to percent. Academic years 2019/20 (April-June and July-September) and 2020/21 (October-December and January-March) relative to mean prior to the pandemic. School grade 8 is the reference category. 95% CI indicated.

Discussion

We study the impact of school closures on the use of mental healthcare services among upper-secondary students. On March 18, 2020, Sweden closed upper-secondary schools until the summer break in mid-June, while schools at lower levels remained open. We exploit this partial school closure to identify the impact of school closures on mental healthcare use by comparing upper (grades 10-12) and lower (grades 7-9) secondary students, before and after the school closure. Difference-in-difference estimates show that upper-secondary students reduced their contacts with mental healthcare services by 4.36 percent compared to lower-secondary students. Lower utilization persists up until the end of the study period in March 2021. We find reductions among all groups, although somewhat larger among males, students from higher-income families, and in school grades 11 and 12. The largest reductions are found for depression and anxiety, and prescriptions for antidepressants.

The reduction was concentrated among students with no contacts with healthcare for mental health issues earlier in the academic year. There is little evidence suggesting this is due to limited access to care. In contrast, three results speak against such interpretation. First, compared to expected rates, the largest reduction was in unplanned contacts with psychiatric care facilities and in contacts with psychiatric emergency units. If upper-secondary students did not get the care they needed via normal channels, we would instead expect substitution towards unplanned visits and emergency units. Second, contacts with mental healthcare services did not increase in the fall of 2021 when schools largely re-opened, and the rates of care contacts

remained low during the winter of 2020/21 when upper-secondary schools conduced both remote and in-person teaching. This suggests that there was no excess demand due to previously unmet needs. Third, healthcare contacts for issues unrelated to mental health and COVID-19 did not change differently between upper- and lower-secondary students. If reduced access for upper-secondary students were to explain the main results, it would then have to be specific to mental healthcare. Further, while many countries have reported extensive disruptions in mental health services (WHO 2021), specialized psychiatric care in Sweden seems to have managed well by moving consultations online (NBHW 2021).

The main contribution of this study is to compare outcomes of students facing in-person and remote schooling during the same time-periods, thereby adjusting for factors that affect both groups similarly. Thus, we do not estimate the total effect of the pandemic but isolate the impact of moving to remote instruction. In line with studies from other countries (Carr et al. 2021; Evensen et al. 2021; Ougrin 2020), we find healthcare contacts with diagnoses for depression and anxiety, and prescriptions of antidepressants to decline relative to the trend in April-June 2020, also among lower-secondary students. However, this decline is small and for the period July 2020 to March 2021, mental healthcare use among lower-secondary students increases at the same rate as in the previous years. Again, this suggest access to mental health services was not severely affected during the pandemic.

Should the results be interpreted as if remote learning improves mental health? As discussed, psychiatric care has been accessible during the pandemic and there are no signs of large unmet needs among upper-secondary students. It is important to take the Swedish context into account when interpreting the results. In an international comparison, the restrictions in the Swedish society have been mild. Although there were recommendations against travelling, meeting with elderly, and socializing in larger groups, there were no stay-at-home orders, and restaurants and gyms largely remained open. Thus, it was possible for upper-secondary students to socialize outside of school. In addition, the full school closure lasted less than 3 months. The potential negative consequences of remote learning are likely larger when students are isolated for longer periods. Another feature of the Swedish setting is that internet penetration is high and the conditions for remote learning are among the best in the world (OECD 2021b). Reports also suggest that the move to remote teaching worked relatively well (Swedish National Agency for Education 2020). As in many countries, standardized tests were largely cancelled which may reduce stress but as tests in lower-secondary school were also cancelled, this alone cannot account for the differences between lower- and upper-secondary students. Among US high school students, there is evidence that the disruption of in-person schooling led to a substantial reduction of bullying, including cyberbullying (Bacher-Hicks et al. 2022). While we are not aware of similar evidence from Sweden, it is another potential channel through which remote learning may have a positive impact on mental health.

Ideally, this study would include self-reported surveys of mental health to validate if the results can be interpreted improvement in mental health. No such information is available, however. The one study of adolescents' mental health in Sweden during the pandemic using survey data, finds no change in mental health among 16-year-olds (Chen et al. 2021). This is in line with our finding of no change in mental health among lower-secondary students (age 14-16). Survey evidence of adolescents' emotional and behavioral problems from other countries during the pandemic, that attempts to adjust for selection as well as time and age trends, find both

deteriorating (Thorisdottier et al. 2021; Luijten et al. 2021; Rogers et al. 2021 and unaffected mental health (Munasinghe et al. 2020; Hafstad et al. 2021).

This study has some limitations. The outcome measure includes contacts with hospitals and specialized psychiatric care, and all prescriptions of drugs in Sweden. However, it does not include information on contacts with primary care or personnel working with healthcare in schools. School closures may have reduced access to school nurses and counselors who may refer students to specialized mental healthcare services. Thus, although the evidence presented suggests otherwise, we cannot entirely rule out this explanation. Another limitation is that other disease containment measures, such as restrictions on nightlife, may have differently affected on upper- and lower-secondary students. A natural limitation is the focus on immediate and medium-term effects. School closures may have reduced learning and opportunities for social interactions that can have detrimental long-term implications.

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Supplementary Materials

Methods and Material

Swedish schools during the pandemic

Upper-secondary schools moved to online instruction on Mars 8, 2020 while schools for younger students remained open. After the summer break upper-secondary schools reopened for in-person instruction but the possibility of reverting to remote instruction remained. Most school relied fully on in-person teaching but some upper-secondary schools had students alternate between remote and in-person classes in order to reduce congestion at the schools and in public transport. In the beginning of the fall term, 80% of the schools taught at the premises and 20% had 10-40% of the classes online (Swedish Schools Inspectorate, 2020). Upper-secondary schools moved back to online instruction on December 7, 2020 to January 24 2021. Thereafter, upper-secondary schools were required to give each student at least 20% of the classes in person at schools (PHA, 2021). Students who were regarded to benefit from in-person instruction, were generally allowed into the school premises (Swedish National Agency for Education (SNAE), 2021b). As the infection rates decreased in the spring of 2021, upper-secondary schools gradually increased in-person schooling (SNAE 2021 a,b,c).

Instruction at lower-secondary schools continued as usual throughout the spring and fall of 2020. From January 2021, lower-secondary schools were allowed to use remote instruction if local conditions so required. A survey by the Swedish Teachers' Union (2021) in February 2021 reports that 88% of their lower-secondary members were to some extent teaching students in-person, while 49% were to some extent teaching without students in the classroom. Remote teaching decreased in the following months and was consistently substantially less prevalent than at the upper-secondary level (SNAE 2021 2021 a,b,c).

Containment measures within Swedish schools consisted of enhanced information and facilities for promoting hand washing and disinfection; if possible, increased distance in classrooms and dining halls; avoidance of large gatherings and close contact between staff and students, and enhanced cleaning of heavily exposed areas. In an international comparison, these measures were mild (Guthrie, 2020) and there were no recommendations or encouragement to use facemasks, no reduction in class size, and no targeted testing or quarantining of students. About the same time as upper-secondary schools closed, The Swedish Public Health Agency issued several other recommendations to reduce the spread of the virus such as: a ban against public gatherings above 50 persons; instructions to restaurants and bars to increase distance between guests; recommendations to stay at home if sick; work from home if possible and avoid unnecessary traveling.

Data

The estimation sample is constructed using the Student Register held by Statistics Sweden. The sample consists of all students in upper- and lower secondary school the academic years 2015/16-2020/21. Students are connected to their parents and to information on healthcare use through a personal identifier. Specifically, students are connected to their biological or adoptive parents using the Multi-Generational register. Information on demographic and socio-economic variables of the parents are taken from the Longitudinal integrated database for health insurance and labor market studies (LISA) maintained by Statistics Sweden. Data on contacts with doctors in specialized psychiatric care and hospital visits is taken from the Patient registers, and drug prescriptions from the Drug register. Both these registers are held by the National Board of Health and Welfare.

Definitions of outcome variables are described in the main text. Most control variables are self-explanatory but the income measure renders a description. The measure of parental income is based on individual disposable income and constructed as follows: We use the average income for the years 2015-2019 and percentile rank each individual by birth cohort and sex. Note that the rank measure is constructed using all individuals in Sweden. For newly immigrated individuals we only use the income after immigration. When dividing the sample by income, a student is coded as "high income" if any of the parents has an income rank in the fourth quartile.

Summary statistics of the main outcome variable, sex, foreign background and parental educational attainment and income percentile are presented in Table S1. The left panel shows values for the academic years 2015/16 to 2019/20 for lower-secondary students and the right panel for upper-secondary students. As can be seen in the table, the use of mental healthcare services increases over time for both groups prior to the pandemic. When upper-secondary schools closed, mental healthcare use among upper-secondary students in April-June 2020 decreased from 85.21 per 1000 to 84.83 per 1000 whereas use among lower-secondary students increased from 75.00 to 78.45 students per 1000. Inspecting the background variables show no drastic change over time. In particular,

judging by these variables there is no change in the composition of students in the academic year 2019/20 that could explain changes in use of mental health services. Students in upper-secondary school are slightly more likely to be male, have foreign background and have parents without university education and lower income. The reason is that students without complete school leaving certificate from lower-secondary school begin preparatory programs in upper-secondary school to attain the requirements in core subjects. These students then stay more than one year in grade 10.

Statistical method

The estimates for the year effects displayed in Figure 1 are retrieved from estimating the model using regression (OLS) separately for lower- and upper secondary school students:

$$y_{it} = \beta_t \, year_t + \boldsymbol{X}_{it} \; + \; \varepsilon_{it}$$

where y_{it} is the outcome for student *i* in year *t*. The variable included in **X** are: Indicators for student sex and birth month, whether the student immigrated to Sweden within the last 4 years or last 8 years, if born abroad or if both parents are born abroad. We also include a range of parental characteristics reflecting the socio-economic position and family situation of the adolescents. Specifically, we include: 7 indicators of parental educational attainment; parental income percentile by year; age category and sex; indicators of unemployment and sickness absence the previous year; indicator of being a retiree; if the parents live together or are married; number of children under age 18 in the household; indicators for missing information on parents in registers.

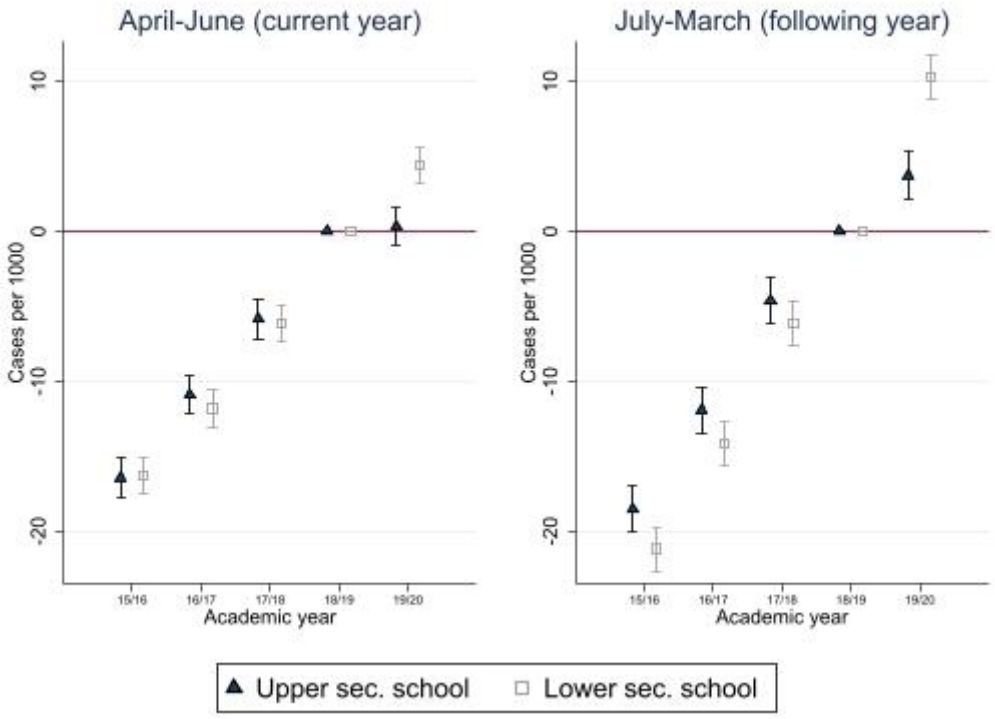
The difference-in-differences estimates displayed in Figure 5 and *Table S5* are retrieved by estimating the following model using linear regression (OLS):

$$y_{ist} = \gamma_s + \delta_t + \sum_{\tau=7,\tau\neq 9}^{12} \beta_\tau \, D_{s\tau} + \; \boldsymbol{X}_{ist} + \varepsilon_{it}$$

Where y_{ist} is the main outcome variable, *t* indicates before or after schools closed and *s* is student school grade. The estimate β_τ show the difference in the outcome variable between school grades s= 7 and 9-12, compared to the reference school grade 8 April-June 2020 compared to the average for the same time-period 2016-2019. This model is also estimated for the periods July-October, November-December and January-March.

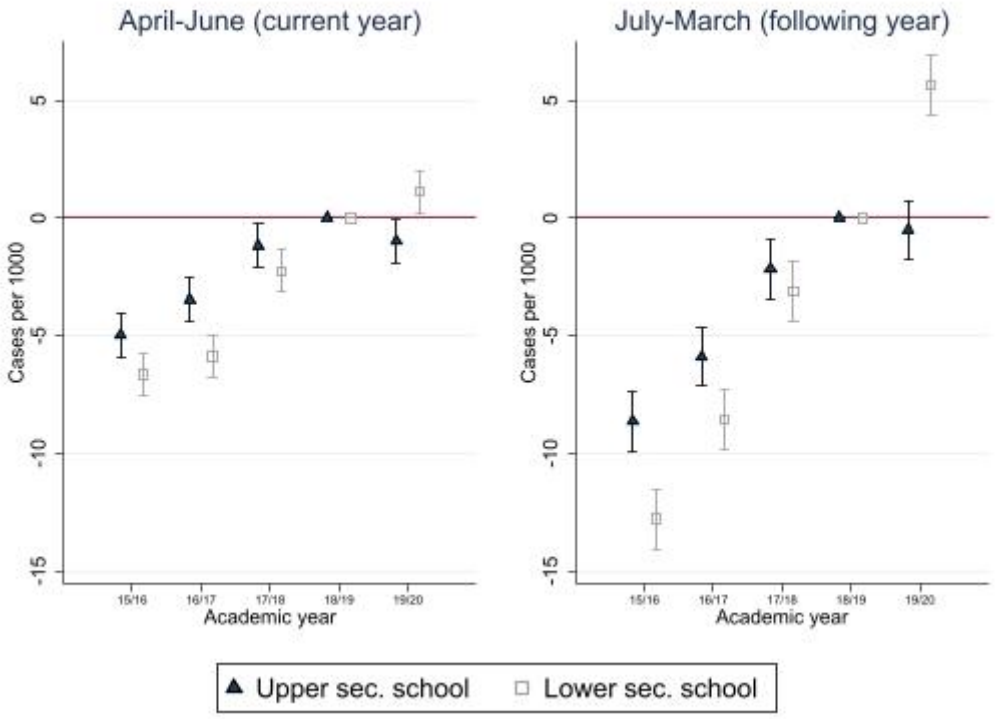
Figures

Figure S1 Trends in use of mental healthcare services



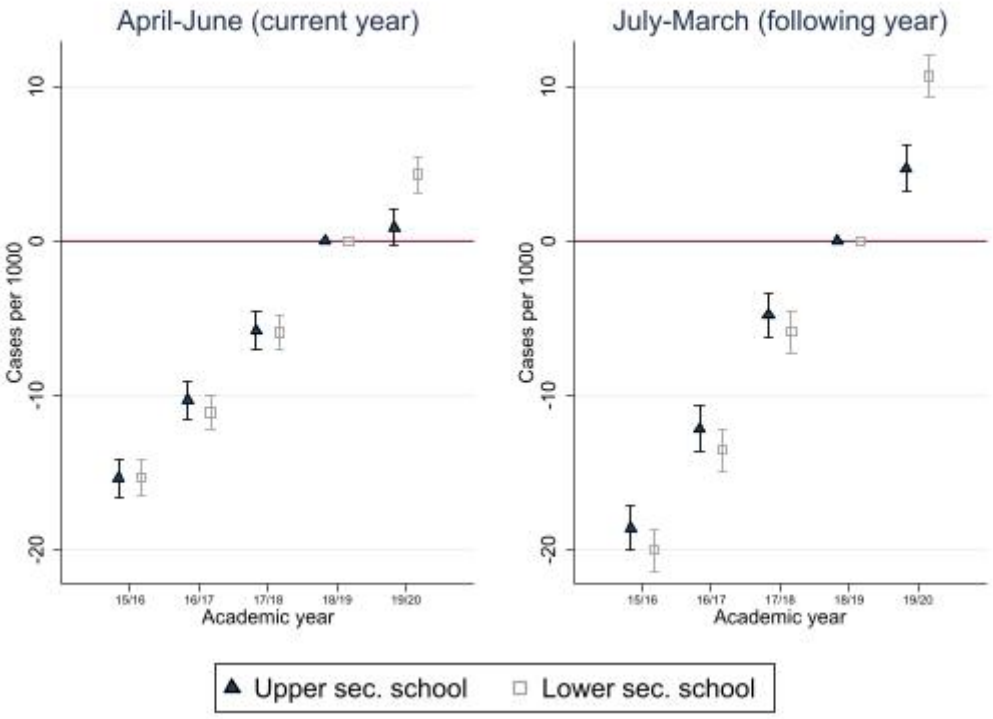
Note: Outcome: main measure of mental healthcare use (diagnoses from healthcare facilities and psychiatric prescription drugs). Estimates from separate linear regressions for upper-secondary and lower-secondary students. Outcomes in the left-hand panel are measured April-June in the current academic year and July-March the coming academic year in the right-hand panel. 95% CI indicated.

Figure S2 Diagnoses from mental healthcare contacts



Note: Outcome: diagnoses from contacts with mental healthcare facilities. Estimates from separate linear regressions for upper-secondary and lower-secondary students. Outcomes in the left-hand panel are measured April-June in the current academic year and July-March the coming academic year in the right-hand panel. 95% CI indicated.

Figure S3 Psychiatric prescription drugs



Note: Outcome: use of psychiatric prescription drugs. Estimates from separate linear regressions for upper-secondary and lower-secondary students. Outcomes in the left-hand panel are measured April-June in the current academic year and July-March the coming academic year in the right-hand panel. 95% CI indicated.

Tables

Table S1 Summary statistics

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Lower secondary students					Upper secondary students				
Academic year	2015/16	2016/17	2017/18	2018/19	2019/20	2015/16	2016/17	2017/18	2018/19	2019/20
Care Apr-Jun in *t*	62.98	66.40	70.41	75.00	78.45	72.77	77.25	80.49	85.21	84.83
Care Jul-Mar in *t*+1	95.27	100.84	106.65	110.72	119.68	112.22	117.38	122.28	125.41	128.15
Care Jul-Mar in *t*	76.72	82.63	88.06	92.28	97.18	102.36	109.80	114.53	120.87	123.37
Male	0.51	0.51	0.51	0.51	0.51	0.52	0.53	0.53	0.53	0.53
Foreign background	0.22	0.23	0.24	0.25	0.25	0.26	0.27	0.29	0.30	0.30
University edu. mother	0.45	0.47	0.48	0.49	0.51	0.41	0.41	0.42	0.43	0.45
University edu. father	0.35	0.36	0.37	0.37	0.38	0.31	0.32	0.32	0.33	0.34
Income percentile mother	49.13	49.79	49.97	50.18	50.25	46.88	46.80	46.37	46.60	46.97
	(30.15)	(30.22)	(30.35)	(30.33)	(30.34)	(30.91)	(31.01)	(31.30)	(31.40)	(31.50)
Income percentile father	49.97	50.47	50.55	50.58	50.67	46.94	46.79	46.28	46.48	46.82
	(31.52)	(31.47)	(31.54)	(31.51)	(31.44)	(32.56)	(32.71)	(32.94)	(32.96)	(33.00)
N	302872	313961	330306	338433	346840	313339	318060	327259	337436	347897

Note: Mean values. Standard deviations in parentheses. Care in *t* refers to the academic year in the column head and *t*+1 to the following year.

Table S2 Difference-in-difference estimates of psychiatric care or prescriptions. Main results and results for subgroups and time-periods

	(1) No controls	(2) Controls	(3) Males	(4) Females	(5) Low income	(6) High income	(7) Recent contact	(8) No recent contact	(9) Care Jul-Mar (following)
	β [95%CI] (p-value)	β [95%CI] (p-value)	β [95%CI] (p-value)	β [95%CI] (p-value)	β [95%CI] (p-value)	β [95%CI] (p-value)	β [95%CI] (p-value)	β [95%CI] (p-value)	β [95%CI] (p-value)
Upper sec × 2016	-0.42 [-2.22,1.38] (0.65)	-1.13 [-2.91,0.65] (0.21)	1.83 [-0.56,4.21] (0.13)	-4.49*** [-7.15,-1.82] (0.00)	0.40 [-2.00,2.80] (0.74)	-2.86* [-5.62,-0.10] (0.04)	-7.98 [-18.50,2.54] (0.14)	0.47 [-0.35,1.29] (0.26)	1.34 [-0.79,3.47] (0.22)
Upper sec × 2017	0.64 [-1.17,2.46] (0.49)	0.26 [-1.54,2.05] (0.78)	0.02 [-2.36,2.41] (0.98)	0.49 [-2.22,3.19] (0.72)	2.74* [0.32,5.16] (0.03)	-2.78* [-5.55,-0.00] (0.05)	4.66 [-5.60,14.92] (0.37)	0.12 [-0.69,0.94] (0.77)	1.37 [-0.77,3.50] (0.21)
Upper sec × 2018	-0.14 [-1.95,1.68] (0.88)	-0.15 [-1.95,1.64] (0.87)	-1.07 [-3.45,1.32] (0.38)	0.91 [-1.80,3.62] (0.51)	1.28 [-1.14,3.70] (0.30)	-1.66 [-4.46,1.13] (0.24)	2.49 [-7.47,12.45] (0.62)	0.61 [-0.20,1.41] (0.14)	0.92 [-1.22,3.06] (0.40)
Upper sec × 2019	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Upper sec × 2020	-3.84*** [-5.66,-2.01] (0.00)	-3.71*** [-5.51,-1.91] (0.00)	-4.26*** [-6.65,-1.88] (0.00)	-3.22* [-5.95,-0.50] (0.02)	-1.64 [-4.07,0.78] (0.18)	-5.93*** [-8.73,-3.13] (0.00)	1.63 [-7.96,11.22] (0.74)	-2.40*** [-3.19,-1.61] (0.00)	-6.05*** [-8.19,-3.90] (0.00)
Mean dep var upper sec 2019	85.21	85.21	67.69	104.90	86.78	87.07	600.34	14.38	125.41
Effect (%)	-4.50	-4.36	-6.30	-3.07	-1.89	-6.81	0.27	-16.70	-4.82
CI95 (%)	[-6.64,-2.36]	[-6.47,-2.25]	[-9.82,-2.77]	[-5.67,-0.48]	[-4.69,0.90]	[-10.03,-3.60]	[-1.33,1.87]	[-22.20,-11.20]	[-6.53,-3.11]
R2	0.001	0.025	0.025	0.028	0.035	0.015	0.034	0.003	0.034
N	3,276,398	3,276,398	1,706,036	1,570,362	1,867,375	1,338,745	331,388	2,945,010	3,276,398

Note: Results from linear regression model specified in main text. Reference year 2019. Specifications presented in (2)-(8) adjust for: sex, birth month, newly immigrated to Sweden, parental foreign background, income, education, income from social security systems, family size and if the biological parents live in the same household.

Table S3 Difference-in-difference estimates for different diagnoses and perscriptions. Outcomes measured April-June

	(1) Depression and anxiety	(2) Disorder due to psychoactive substance use	(3) Self-destructive behavior	(4) Eating disorder	(5) Anti-depressants	(6) Adhd medication	(7) Diagnoses unrealted to mental health and COVID-19
	β [95%CI] (p-value)	β [95%CI] (p-value)	β [95%CI] (p-value)	β [95%CI] (p-value)	β [95%CI] (p-value)	β [95%CI] (p-value)	β [95%CI] (p-value)
Upper sec × 2016	0.34 [-0.53,1.21] (0.44)	0.17 [-0.13,0.46] (0.28)	-0.10 [-0.33,0.13] (0.40)	0.21 [-0.12,0.54] (0.21)	-2.61*** [-3.71,-1.51] (0.00)	0.61 [-0.56,1.78] (0.31)	0.31 [-0.80,1.41] (0.59)
Upper sec × 2017	0.57 [-0.31,1.45] (0.20)	0.38* [0.08,0.67] (0.01)	-0.15 [-0.38,0.07] (0.18)	0.36* [0.02,0.69] (0.04)	-1.20* [-2.31,-0.09] (0.03)	0.88 [-0.30,2.05] (0.14)	0.96 [-0.12,2.05] (0.08)
Upper sec × 2018	-0.17 [-1.05,0.71] (0.70)	0.29* [0.00,0.58] (0.05)	-0.09 [-0.32,0.14] (0.46)	0.04 [-0.30,0.37] (0.82)	-0.96 [-2.07,0.16] (0.09)	0.39 [-0.78,1.56] (0.51)	0.31 [-0.76,1.38] (0.57)
Upper sec × 2019	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Upper sec × 2020	-1.49*** [-2.36,-0.63] (0.00)	-0.10 [-0.39,0.19] (0.51)	-0.13 [-0.35,0.09] (0.25)	0.11 [-0.22,0.45] (0.50)	-1.80** [-2.93,-0.68] (0.00)	-0.85 [-2.04,0.34] (0.16)	0.06 [-0.99,1.10] (0.92)
Mean dep var upper sec 2019	20.28	2.56	1.33	2.45	38.42	27.34	25.61
Effect (%)	-7.37	-3.78	-9.72	4.69	-4.70	-3.12	0.22
CI95 (%)	[-11.65,-3.08]	[-15.12,7.56]	[-26.27,6.82]	[-9.02,18.40]	[-7.62,-1.77]	[-7.46,1.23]	[-3.86,4.29]
R2	0.009	0.001	0.001	0.003	0.016	0.018	0.001
N	3,276,398	3,276,398	3,276,398	3,276,398	3,276,398	3,276,398	3,276,398

Note: Results from linear regression model specified in main text. Reference year 2019. Model adjust for: sex, birth month, newly immigrated to Sweden, parental foreign background, income, education, income from social security systems, family size and if the biological parents live in the same household.

Table S4 Difference-in-difference estimates for type of care. Outcomes measured April-June

	(1) Diagnoses	(2) Psychiatric drugs	(3) Planned care	(4) Unplanned care	(5) Emergency unit	(6) Psych emergency unit
	β [95%CI] (p-value)	β [95%CI] (p-value)	β [95%CI] (p-value)	β [95%CI] (p-value)	β [95%CI] (p-value)	β [95%CI] (p-value)
Upper sec × 2016	1.18 [-0.13,2.49] (0.08)	-1.03 [-2.69,0.63] (0.22)	1.38* [0.09,2.67] (0.04)	0.25 [-0.45,0.95] (0.49)	-0.28 [-0.69,0.14] (0.19)	-0.32* [-0.57,-0.06] (0.01)
Upper sec × 2017	2.08** [0.78,3.38] (0.00)	0.13 [-1.54,1.80] (0.88)	1.94** [0.65,3.22] (0.00)	0.56 [-0.13,1.25] (0.11)	0.45* [0.03,0.87] (0.04)	0.12 [-0.13,0.38] (0.34)
Upper sec × 2018	0.87 [-0.44,2.18] (0.19)	-0.31 [-1.98,1.36] (0.71)	0.69 [-0.60,1.98] (0.29)	0.99** [0.30,1.68] (0.00)	0.11 [-0.31,0.53] (0.61)	0.20 [-0.06,0.45] (0.13)
Upper sec × 2019	ref	ref	ref	ref	ref	ref
Upper sec × 2020	-1.92** [-3.22,-0.62] (0.00)	-3.05*** [-4.73,-1.36] (0.00)	-1.38* [-2.66,-0.11] (0.03)	-1.65*** [-2.30,-1.00] (0.00)	-0.89*** [-1.30,-0.49] (0.00)	-0.38** [-0.62,-0.14] (0.00)
Mean dep var upper sec 2019	40.91	72.94	38.95	11.91	4.92	2.24
Effect (%)	-4.70	-4.18	-3.56	-13.88	-18.19	-16.92
CI95 (%)	[-7.87,-1.53]	[-6.49,-1.87]	[-6.84,-0.27]	[-19.35,-8.42]	[-26.45,-9.92]	[-27.73,-6.12]
R2	0.012	0.023	0.011	0.002	0.002	0.001
N	3,276,398	3,276,398	3,276,398	3,276,398	3,276,398	3,276,398

Note: Results from linear regression model specified in main text. Reference year 2019. Model adjust for: sex, birth month, newly immigrated to Sweden, parental foreign background, income, education, income from social security systems, family size and if the biological parents live in the same household.

Table S5 Difference-in-difference estimates by school grade. Outcomes for different time-periods

	(1) Apr-June 2020		(2) Jul-Sep 2020		(3) Oct-Dec 2020		(4) Jan-Mar 2021	
	β (p-value)	[95%CI]	β (p-value)	[95%CI]	β (p-value)	[95%CI]	β (p-value)	[95%CI]
School grade 7 × 2020	-0.95 (0.43)	[-3.29,1.40]	-1.77 (0.14)	[-4.14,0.59]	-0.44 (0.73)	[-2.95,2.08]	0.82 (0.54)	[-1.77,3.40]
School grade 8	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
School grade 9 × 2020	-0.71 (0.58)	[-3.20,1.78]	-2.11 (0.10)	[-4.60,0.37]	-3.16* (0.02)	[-5.78,-0.54]	-4.28** (0.00)	[-6.95,-1.62]
School grade 10 × 2020	-2.64* (0.03)	[-5.07,-0.21]	-3.83** (0.00)	[-6.27,-1.40]	-3.31* (0.01)	[-5.88,-0.74]	-4.61*** (0.00)	[-7.22,-2.00]
School grade 11 × 2020	-5.03*** (0.00)	[-7.52,-2.55]	-6.55*** (0.00)	[-9.02,-4.07]	-8.69*** (0.00)	[-11.28,-6.10]	-9.16*** (0.00)	[-11.79,-6.54]
School grade 12 × 2020	-4.41*** (0.00)	[-6.90,-1.92]	-5.09*** (0.00)	[-7.57,-2.60]	-5.45*** (0.00)	[-8.04,-2.87]	-3.53** (0.01)	[-6.16,-0.90]
Mean dep var gr 7 2019	64.90		63.15		73.16		79.53	
Effect (%) gr 7	-1.46	[-5.07,2.15]	-2.81	[-6.55,0.93]	-0.60	[-4.04,2.84]	1.03	[-2.22,4.27]
Mean dep var gr 9 2019	84.21		79.96		89.42		94.09	
Effect (%) yr 9	-0.84	[-3.80,2.11]	-2.64	[-5.75,0.46]	-3.54	[-6.47,-0.61]	-4.55	[-7.38,-1.72]
Mean dep var gr 10 2019	91.67		87.45		97.66		102.00	
Effect (%) gr 10	-2.88	[-5.53,-0.23]	-4.39	[-7.17,-1.60]	-3.39	[-6.02,-0.76]	-4.52	[-7.08,-1.96]
Mean dep var gr 11 2019	85.52		79.79		88.29		88.98	
Effect (%) gr 11	-5.89	[-8.79,-2.98]	-8.21	[-11.31,-5.10]	-9.84	[-12.78,-6.91]	-10.30	[-13.25,-7.35]
Mean dep var gr 12 2019	76.13		69.90		74.41		75.69	
Effect (%) gr 12	-5.80	[-9.07,-2.525]	-7.28	[-10.83,-3.724]	-7.33	[-10.80,-3.851]	-4.66	[-8.13,-1.187]
R2	0.024		0.025		0.027		0.028	
N	3,276,398		3,276,398		3,276,398		3,276,398	

Note: Results from linear regression model specified in supplementary materials. Reference school grade is grade 8. The model adjust for: sex, birth month, newly immigrated to Sweden, parental foreign background, income, education, income from social security systems, family size and if the biological parents live in the same household