Supplementary Information for

The effects of school closures on SARS-CoV-2 among parents and teachers

Jonas Vlachos, Edvin Hertegård, Helena Svaleryd

Helena Svaleryd
E-mail: helena.svaleryd@nek.uu.se

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Supporting Information Text

The development of the pandemic and non-pharmaceutical interventions. The first case of SARS-CoV-2 in Sweden was reported on January 31, 2020, and the disease was classified as a danger to public health and to society on the following day (1). Among other things, this classification means that all documented cases of active infection have to be reported to the Public Health Agency. The first death from COVID-19 occurred on March 11. The daily number of deaths increased rapidly and peaked in the first half of April whereafter the daily number of deaths declined gradually. By the end of the school year in mid-June, the 7-day average of daily deaths was around 30 and the cumulative number of deaths 5140 (51 per 100 000 inhabitants).

The hardest hit region in both absolute and relative terms was the Stockholm region with 2.4 million inhabitants. Stockholm recorded 2211 deaths (93 per 100 000) and 16 275 cases (685 per 100 000) by mid-June. In deaths per 100 000 inhabitants, Stockholm was followed by Sörmland (79), Västmanland (55) and Dalarna (52). The second largest region of Sweden, Västra Götaland, had by June 15 reported 649 deaths among its 1.7 million inhabitants. Testing scaled up faster in this region than in Stockholm and the total number of cases was 11 000. The region of Skåne with 1.4 million inhabitants was less affected and reported 16 deaths per 100 000 and a total of 2300 cases by mid-June.

The Swedish Public Health Agency introduced several measures to reduce the transmission of the virus (2). On March 10, a recommendation against unnecessary visits to care facilities was issued and on March 11 public gatherings of more than 500 people were banned. On March 13, people were recommended to stay at home when having symptoms of illness and those who could work from home were recommended to do so on March 17. On March 18, upper secondary schools and institutions of higher education moved to online instruction. On March 19, a recommendation against unnecessary travel was issued and on March 24, restaurants and bars were instructed to increase the distance between costumers. Public gatherings above 50 persons were banned on March 27 and visits to elderly care facilities were banned the following day. On April 1, stricter recommendations on social distancing for the public were issued. On June 13, the recommendation against unnecessary travel was lifted. Throughout the period, there was no official recommendation that those without symptoms should stay at home, even if the household was shared with individuals with confirmed SARS-CoV-2 infection.

Mobility both within and between Swedish regions declined substantially as a response to the pandemic and the recommendations issued by the authorities (3). The distance individuals moved from their homes during a day was substantially reduced and the decline in mobility was similar for residents in areas with different socioeconomic and demographic characteristics (visible minorities, highly educated, poor, and being 70 years or older) (4).

Swedish schools during the pandemic. Compulsory schools (age 7–16) were kept open for instruction and to reduce transmission the following precautionary measures were recommended (5): enhanced facilities for hand washing and disinfection; posters encouraging hand washing; increased distance in classrooms and dining halls, if possible; avoidance of large gatherings, as far as possible; minimize activities like open houses and parental meetings; increased outdoor activities, if possible; avoidance of close contacts between staff and students and between students; enhanced cleaning of heavily exposed areas and keyboards/tablets. Compared to school opening policies in other countries, the precautionary measures in Sweden are best described as mild (6). In particular, there is no mandated quarantine of those exposed who do not show symptoms, no imposed reductions of class size and no recommendations concerning the use of face masks.

On March 18, upper secondary schools and institutions of higher education moved to online instruction. Upper secondary schools thus closed for normal instructions just as the number of deaths and ICU admissions began to increase (see Fig. 1 in the main text). Although upper secondary school moved to online teaching, some teachers were still teaching online from the school premises. According to a survey conducted by a large teachers' union during the last week of April and first week of May, 21 percent taught from the school, 46 percent partly from home, and 33 percent only from home (7). As expected, compulsory school teachers mainly taught from school; 2 percent of the teachers in compulsory schools had been partly teaching online from home and 1 percent had only been teaching from home. There have also been media reports of substantial student absenteeism in compulsory schools. Again there are no official reports but according to the same survey, 18 percent of compulsory students were absent on a typical day. In a survey of 27 compulsory schools conducted by the National Board of Education during late April, 7 schools reported that absenteeism among compulsory school students was about normal, 13 that there was an increase in absenteeism of between 20 and 50 percent, and 7 stated an increase of more than 50 percent (8). The conclusion drawn from this survey is that student absenteeism increased, but not dramatically so.

Data and sample restrictions. The sample of parents is constructed as follows. We define household adults who are exposed to their own children (biological or adopted) or a new partner's children from a previous relationship as parents. For separated parents, we use the household identifier in LISA to identify any current partner. This enables us to identify new couples who are either married or have common children. Households consisting of unmarried cohabitant couples without common children cannot be identified and will be categorized as single households. The study population consists of parents who have children in school years 7–12 in the household, or biological children in these school years living in the same region. Because parents are less likely to interact regularly with children living at a distance, only children residing in the same region are considered in the analysis. There are 21 regions in Sweden and they are thus relatively large geographical areas. There were also recommendations against leaving the region of residence during most of the spring 2020.

We sort parents by the age of the youngest child connected to the parents in the household or through biological links. Parents are considered exposed to lower secondary schools if their youngest child is enrolled in school years 7–9. Unexposed parents are defined by their youngest child being enrolled in upper secondary school. In the analysis we focus on parents with the youngest child in school years 9 and 10 since they are likely to be the most similar in other aspects, except for parents with their youngest child in the 9th school year being exposed to an open school. We further exclude those born outside of Sweden, the Nordics, and the EU. After this restriction, the main sample consists of 166 630 parents connected to school years 9 and 10. 480 291 parents are connected to school years 7 though 12.

The teacher sample consists of teachers working in lower and upper secondary schools according to the Teacher Register. Teachers with children born in 2019 are excluded as they are likely to be on parental leave during the spring of 2020. We also exclude those recorded as being on leave of absence during the fall of 2019. The final sample consists of 72 946 lower and upper secondary teachers. In a descriptive analysis we include lower and upper primary school teachers (school years 1–6) identified in the Teacher Register. When including these, the teacher sample consists of 137 213 individuals. For the sample of partners to lower and upper secondary teachers, we connect partners to teachers using the household identifier from LISA. This enables us to identify partners who are either married to or have common children with the teacher. The resulting sample consists of 47 383 partners.

Our main outcome variable is positive PCR tests reported to the Public Health Agency but we also analyze the incidence of COVID-19 diagnoses from healthcare visits and severe cases of COVID-19 (hospitalizations and deaths) reported to the National Board of Health and Welfare. The first case of SARS-CoV-2 in Sweden was reported on January 31, 2020, and the disease was classified as a danger to public health and to society on the following day (1). Among other things, this classification means that all documented cases of active infection have to be reported to the Public Health Agency. Testing capacity was slow to expand and from March 13 (week 11), testing was directed towards healthcare employees and individuals with symptoms of COVID-19 in need of healthcare. As shown in Fig. S1, testing increased substantially from early June (week 23). Healthcare is the responsibility of Sweden's 21 healthcare regions as is testing for SARS-CoV-2. Thus, there are regional differences in testing capacity as well as rules and recommendation regarding testing. Some regions have recommended not to test children under 16 (for example Västra Götaland and Uppsala) and some have not had any age restrictions (for example Skåne). The number of detected cases does therefore not well reflect the actual rate of infections and the rate of positive tests remained high throughout June (week 27). By June 15, a total of 383 000 PCR tests had been performed (3 800 per 100 000 inhabitants) (9).

Covariate balance. For estimation of the causal effect on parents the identification strategy hinges on the similarity of parents with their youngest child in school years 9 and 10. Apart from a 1-year age difference, these groups should be balanced on covariates in order to be valid counterfactuals. We test this assumption by showing balancing tests where we first use OLS to linearly predict the incidence of SARS-CoV-2 using the observable covariates (apart from age group effects) of parents with the youngest child in school years 7–12. Using this prediction as the dependent variable, we next run an OLS regression using only indicator variables for school year of the youngest child in the family (school year 10 is the reference category). Fig. S2 shows the estimates from this second regression for the main sample of parents. The corresponding balancing test when non-EU migrants are included is shown in Fig. S3. The specified regressions equations are shown below. The outcome variable is actual infections (regression [1]) or predicted infections (regression [2]), and $\mathbf{X}$ is a vector capturing spouse's occupation, missing information for spouse, educational level, municipality of residence, log disposable family income, zero income, region of origin of birth, and sex. $year_{i,g}$ are indicator variables capturing the school year of the youngest child in the household. Equation [1] shows the regression equation used to estimate the predicted infections, which is subsequently used as the dependent variable in the balancing equation [2].

$$y_i = \beta_0 + \mathbf{X}'\boldsymbol{\gamma} + \varepsilon_i \qquad [1]$$

$$y_{i,predict} = \beta_0 + \sum_{\substack{g=7 \\ g\neq 10}}^{12} year_{i,g} + \varepsilon_i \qquad [2]$$

In order to judge the importance of covariates, odds ratios without controlling for covariates are shown in Fig. S4. Panels S4a and S4b show odds rations when only controlling for age group effects and panels S4c and S4d show odds rations without any controls. Odds ratios with covariates for the main sample of parents are shown in panel a) of Fig. S5 and panel b) shows results when including all parents. The OLS estimates for both samples of parents, with all covariates and only age group effects and sex, are shown in Table S3. Table S3 also shows estimates for teachers and teachers' partners, with the full set of covariates and only age group effects and sex. Age groups are included since the parental sample is imbalanced on age by construction and sex is included since there are more female teachers in lower secondary school. In the parental sample, which is roughly balanced on sex, the incidence of positive tests among women is 9.47 cases/1000 and among men 5.77 cases/1000. This difference may be due to educational, occupational or potential sex differences in testing or prevalence of COVID-19.

Results including primary school teachers. We extend the population of teachers at open schools to include lower (school years 1–3) and upper (school years 4–6) primary school teachers. Results for confirmed PCR-tests and COVID-19 diagnoses when controlling for covariates are shown in Table S2.

Additional results and robustness tests. The propensity to get tested for SARS-CoV-2 could be affected by being connected to open and closed schools, regardless of health status. This is less of a concern for COVID-19 diagnoses made by the healthcare sector, especially severe cases which require hospital care or cause death. Results for severe cases, defined as admittance to hospital or death due to COVID-19, are presented for all groups in Table S1.

Some lower secondary schools spontaneously moved to online instruction and may thus be classified as having on-site instruction when they in fact conducted the teaching online. No official records on such closures exist but media searches reveal that they were rare and short-lived (see below). Privately managed independent lower secondary schools are over-represented in reports on proactive closures and we therefore exclude such schools as a robustness test. Students attending independent schools are generally from a more advantaged socioeconomic background and excluding them introduces imbalance to the sample of parents (Fig. S6). OLS estimates excluding independent lower secondary schools for parents are shown in Table S4. Corresponding results for teachers and their partners are shown in Table S5.

Upper secondary schools were allowed to let small groups of students complete practical elements of education and assignments, provided that this could be done safely (10). Such practices may have been more common at vocational programs and as a robustness test we exclude parents exposed to such upper secondary programs. This amounts to excluding parents of relatively disadvantaged socioeconomic background, which means that the exclusion introduces imbalance among parents (Fig. S6). OLS estimates imposing this exclusion are shown in Table S4.

The baseline specifications controls for the occupation of teachers' partners. As a robustness test, we instead drop the teachers and partners who are exposed to the healthcare sector through the partners' occupation (occupational codes 15, 22, 32 and 53). The results are shown in Table S5.

We use an alternative measure of exposure to lower secondary school for parents. Parents are then defined as exposed if they have a child in the household, or a child residing in the same region, in lower secondary school. Families with children too old to be in secondary school are dropped, as are families whose youngest child attends school below year 7. We control for having a child in school years 11 and 12 and the results presented in Table S4 thus shows the impact of being exposed to a child in lower secondary school compared to being exposed to a child in upper secondary school year 10. Table S4 also shows results where we pool parents with the youngest child in school years 8–11 and 7–12.

Household size tends to decrease in student age and Table S6 shows results for parents when controlling for this variable. Table S7 presents the sensitivity to using the cut-off dates March 25 and April 16 for parents, teachers and teachers' partners.

Heterogeneity analysis. The expected impact of school closures on virus transmission depends mainly on the magnitude of contact reduction. Two factors that may be of importance for the effect is population density and how widely spread the virus was prior to schools closing. A study of US districts show that transmission of SARS-CoV-2 increases with population density (11). To investigate this matter we implement a heterogeneity analysis by district population density, categorizing districts with a population density above the 75th percentile as high density districts.

Timing has been shown to be important for the effectiveness of NPIs (12). We therefore investigate whether the impact of school closures depends on the level of virus transmission prior to school closure. Regions with above the populated weighted median spread of 12 cases per 100 000 are categorized as high spread regions, i.e. the regions (cases per 100 000 in parenthesis): Stockholm (20), Uppsala (16), Östergötland (16), Skåne (16), Sörmland (13) and Jönköping (12).

The econometric model is modified by adding interaction terms between indicators for high population density, respective high initial contagion, and exposure to lower secondary school as well as interactions with all control variables except for the municipality indicators. The results are reported in Table S8.

Distribution of cases across schools. Although limited by the low testing rate, an illustration of the aggregation of cases across schools and over time can provide some evidence of the role of super-spreading events. To investigate whether there is substantial heterogeneity across schools, we aggregate cases across schools for parents and teachers, respectively. Cases among parents connected to a school through students in school years 7–12 are aggregated to the school level which means that cases among parents to several children are connected to more than one school. When excluding schools with less than 50 connected parents there are 1455 lower and 1149 upper secondary schools in the data. Among these schools, 25 percent of upper secondary and 32 percent of lower secondary schools had no cases. Since upper secondary schools on average are larger (397 connections compared to 312 for lower secondary schools) we mechanically expect more cases in upper secondary schools. Fig. S7 shows the fraction of total cases in lower respective upper secondary schools with one to 28 cases. For both types of schools, a majority of cases occurred at schools with few cases. To analyze how the cases are clustered over time, we aggregate the cases into episodes. If all cases within a school occur the same or adjacent week it is coded as one episode. If cases are more dispersed over time, the school is coded as having more than one episode of infection outbreaks. Fig. S8 displays the fraction of schools with at least two cases in total that have one or more than one episodes. The pattern is similar for lower and secondary schools, with about 60 percent of the schools having one outbreak episode and 40 percent having more than one episode.

We conduct the same analysis for teachers at schools with more than 5 teachers. As for the analysis of parents, there are no cases in a majority of schools (90 percent of lower secondary and 93 percent of upper secondary schools). Moreover, most cases are recorded in schools with only one case (Fig. S7). Among upper secondary schools there are no schools with more than two cases, whereas among lower secondary schools there are some schools with three or more cases. The main analysis shows that keeping lower secondary schools open resulted in approximately 100 additional cases among lower secondary school teachers. According the patterns of distribution presented here, about a third of these can be found in schools with many cases and two thirds in schools with only one case. Turning to the analysis of outbreak episodes there is some indication of more clustering of outbreaks among teachers in lower secondary than upper secondary schools (Fig. S8).

Students. We show descriptive results of infection rates for students by school year in Table S9. Due to the discussed age restrictions for testing and risk of differing behavior for students over 18, we show results for students below age 18 in school years 7–10. As with parents and teachers, we control for observable characteristics such as sex, region of origin, and mother and father log disposable income, occupation, region of origin, education, missing values, and number of siblings in different age groups. We restrict attention to students with parents born within the EU and Nordics due to balancing of covariates concerns.

Media searches. In order to get information on spontaneous closures of lower secondary schools, media searches were conducted using the service Mediearkivet/Retriver and on Sveriges Radio's web page (public service radio with substantial local presence). Search terms were permutations of "school closure" (skolstängning/skola stängd), "distance education" (distansundervisning), "online education" (onlineundervisning), "corona" and "covid". Results for individual schools were followed by web searches to find more information on each particular case. Spontaneous closures were recorded as proactive if they did not occur as a result of cases detected at the school and reactive otherwise. Provided that information is available, a closure is labelled as brief if the duration was less than a week.

In total, reports on 40 closures were found (27 among privately managed independent schools). 29 of these were proactive (22 among independent schools) while 11 were reactive (5 among independent schools). Spontaneous closures thus appear to have been rare and independent schools are vastly over-represented among those that closed proactively. Two of the reactive closures were on advice from the local disease protection officer and they both occurred late in the school year (June 6 and 8). Information on the duration was usually not available, but of the 18 reports from which the duration can be judged, 12 were brief. Several of the closures were also partial, meaning that school days were cut short, rolling schedules introduced, or that instruction partially moved online. Details on each specific report are available from the authors.

Cases, deaths and the case fatality rate. To extrapolate the expected effect of school closure on the number of deaths in Sweden we derive the case fatality ratio (CFR) for different age groups. CFR is calculated by dividing the number of deaths with the number of cases and hence crucially depend on the testing regime. Table S10 shows the incidence of detected SARS-CoV-2 in different age groups until June 15, 2020, and the number of deaths among these cases reported until July 25. The numbers are shown both including and excluding healthcare workers, for which testing was more accessible. The CFR increases with age, except for the higher value for the youngest age group due to one dead child. This child was younger than one years old and thus not directly exposed to schools. The average age among teachers is 48, their partners 49 and parents 50 years old. Based on the CFR distribution in Table S10 we calculate the expected effect on mortality among lower secondary parents using a CFR of 1.1 percent.

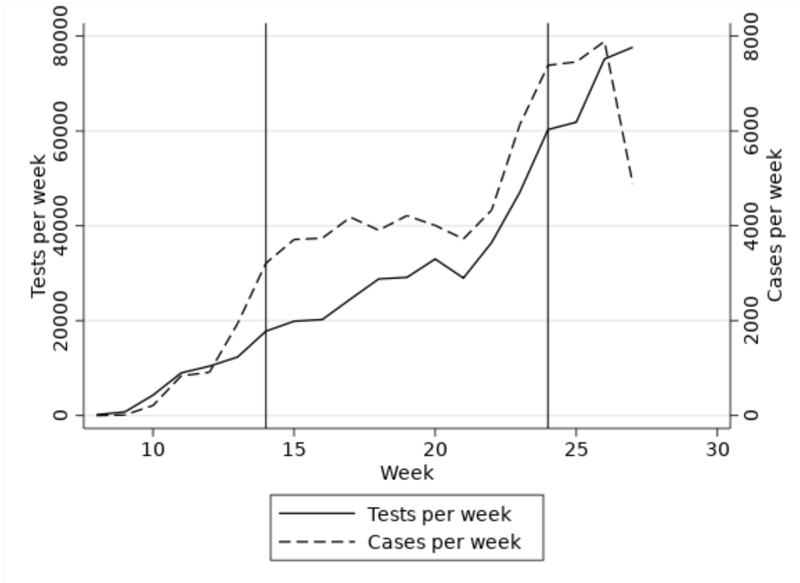


Fig. S1. Tests and cases per week. Weekly number of PCR tests and positive cases. Vertical lines indicate weeks 14 and 24, the approximate period of analysis. Data from the Public Health Agency (9).

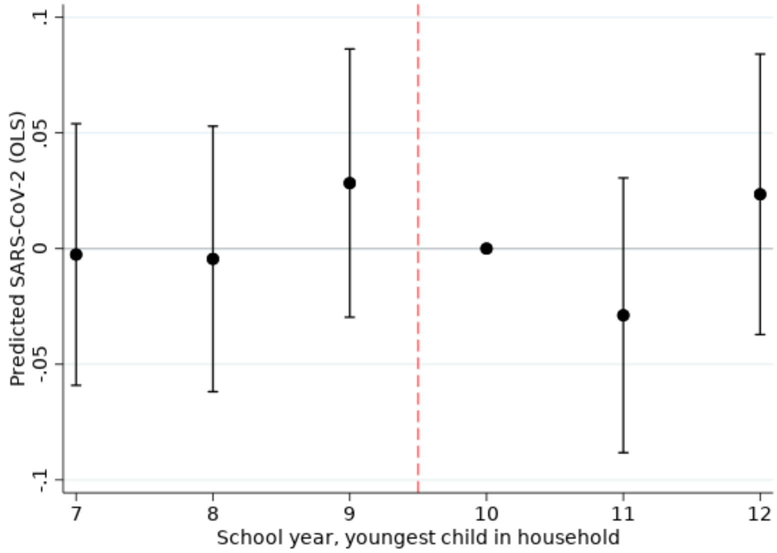


Fig. S2. Covariate balance, main sample. Predicted SARS-CoV-2 regressed on school year of the youngest child in the household for parents born within EU and Nordics. Predicted outcome using sex, occupation, educational attainment, income, regions of residence and of origin for parents. The reference category is school year 10 and 95% confidence intervals are indicated.

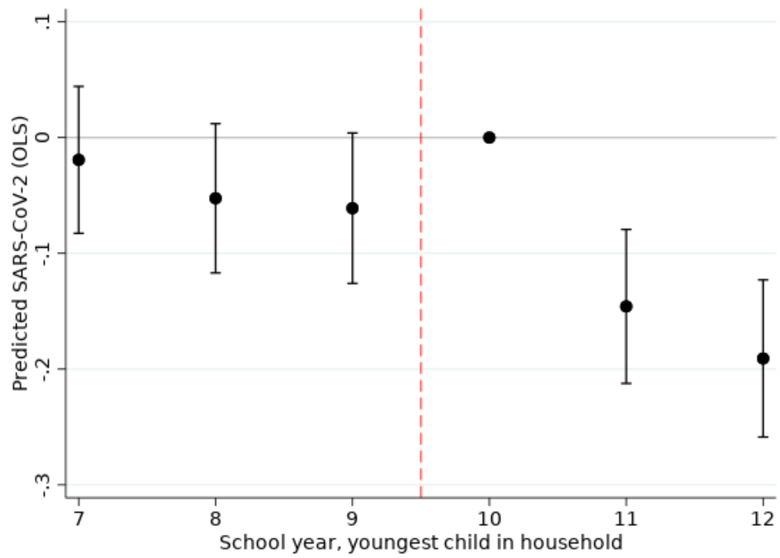
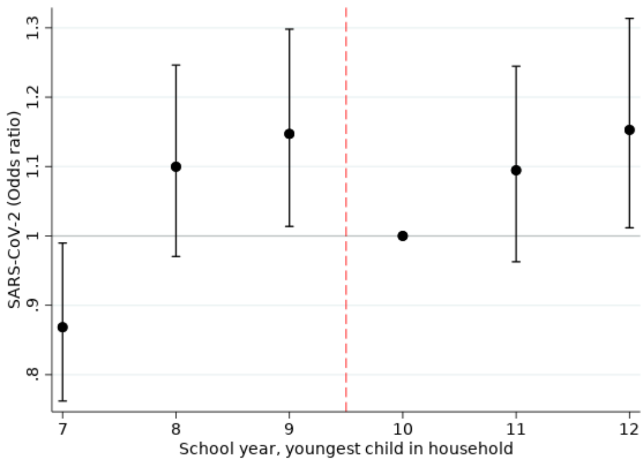
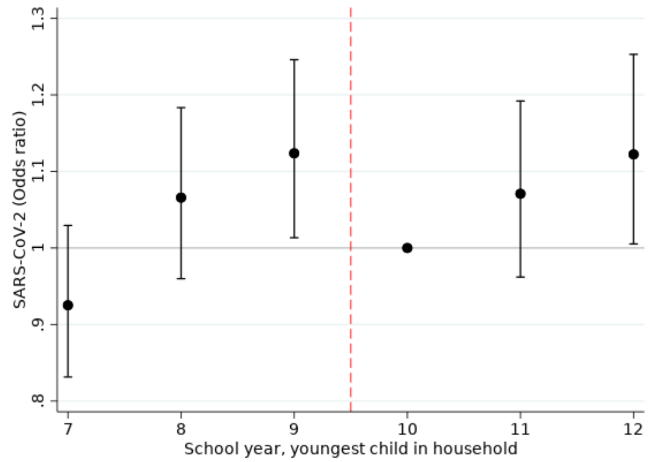


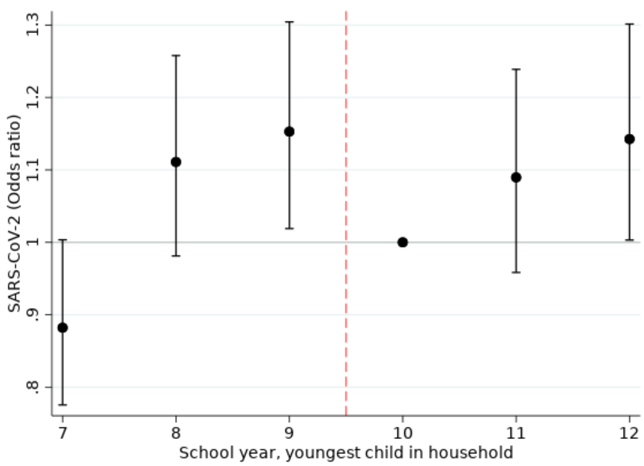
Fig. S3. Covariate balance, all parents (including non-EU migrants). Predicted SARS-CoV-2 regressed on school year of the youngest child in the household for all parents. Predicted outcome using sex, occupation, educational attainment, income, regions of residence and of origin for parents. The reference category is school year 10 and 95% confidence intervals are indicated.



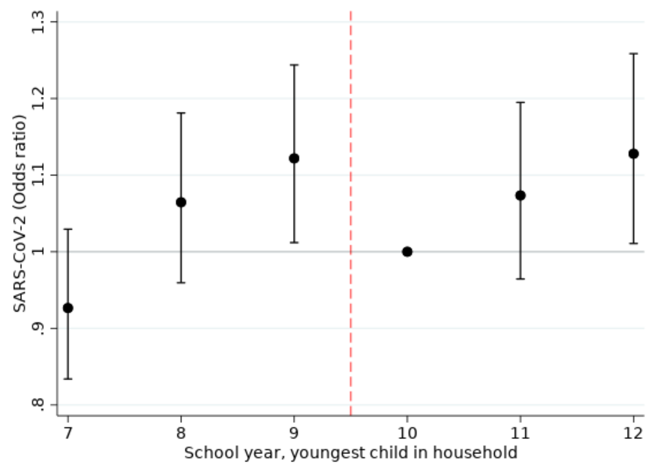
(a) Age group controls - Parents born within EU and the Nordics



(b) Age group controls - All parents

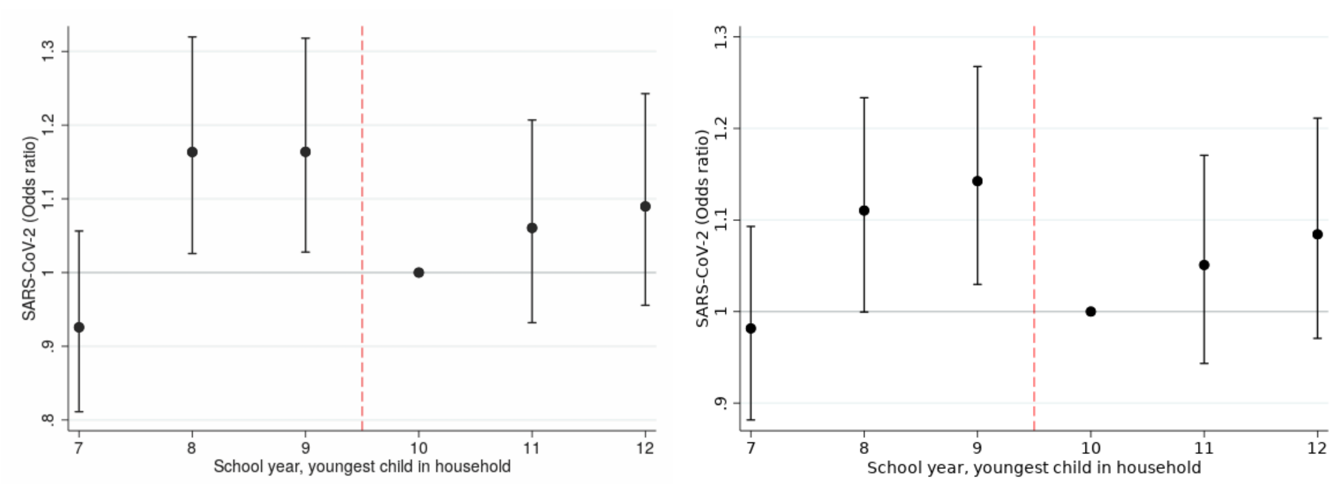


(c) Excl. all controls - Parents born within EU and the Nordics



(d) Excl. all controls - All parents

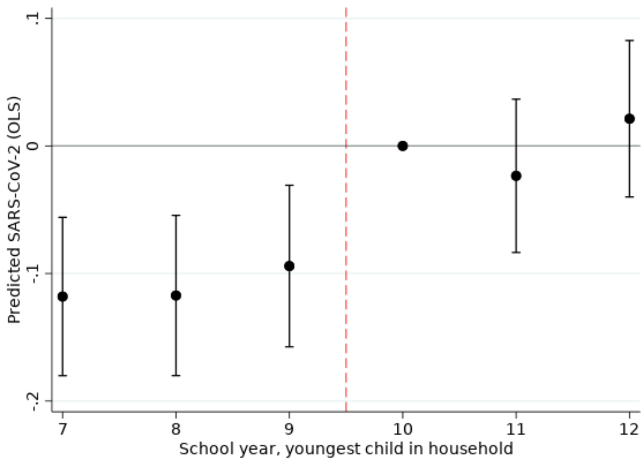
Fig. S4. Results excluding covariates. SARS-CoV-2 odds ratios for parents by school year of the youngest child in the household excluding all control variables (except for age group effects in Panel S4a and S4b and y_{prior}). Odds ratios estimated using logistic regression. The reference category is school year 10 and 95% confidence intervals are indicated. Fig. S4a and Fig. S4c show outcomes for parents born within the EU and the Nordics, which is our main study population. Fig. S4b and Fig. S4d show outcomes including all parents.



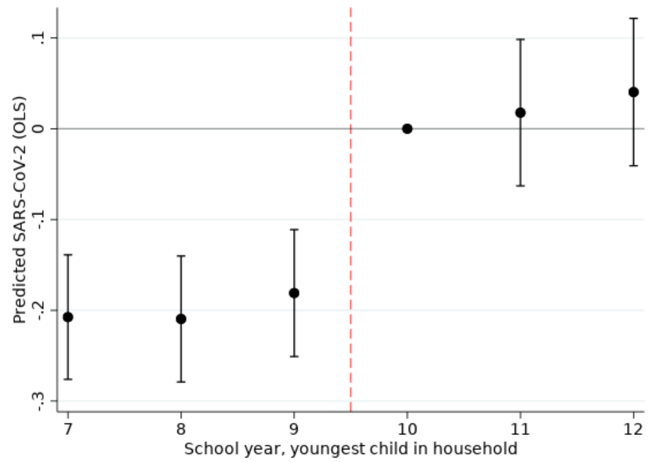
(a) Parents born within EU and the Nordics

(b) All parents

Fig. S5. Results including covariates. SARS-CoV-2 odds ratios for parents by school year of the youngest child in the household. Odds ratios estimated using logistic regression. The reference category is school year 10 and 95% confidence intervals are indicated. Fig. S5a shows outcomes including parents born within the EU and the Nordics, which is our main study population. Fig. S5b shows outcomes including all parents.



(a) Predicted outcome - Excl. private indep. schools



(b) Predicted outcome - Excl. vocational program links

Fig. S6. Covariate balance for subsamples. Predicted SARS-CoV-2 regressed on school year of the youngest child in the household for parents born within EU and the Nordics, excluding private independent schools and vocational program links separately. Predicted outcome using sex, occupation, educational attainment, income, regions of residence and of origin for parents. The reference category is school year 10 and 95% confidence intervals are indicated. Fig. S6a shows outcomes excluding private independent school links. Fig. S6b excludes vocational program links.

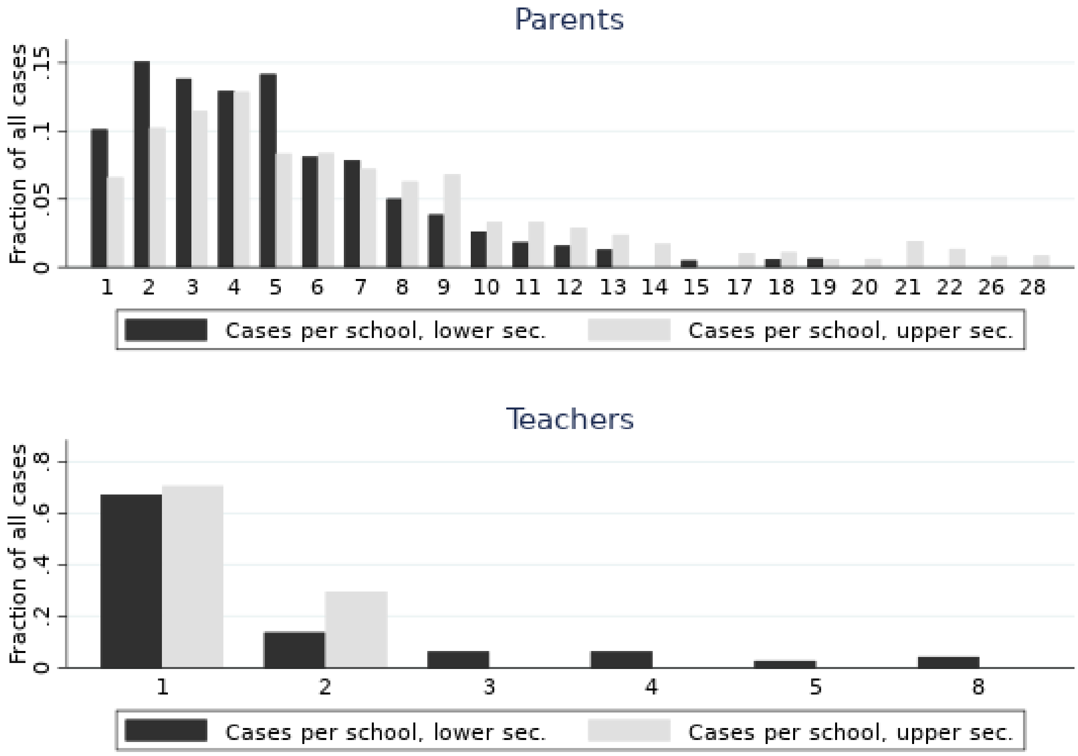


Fig. S7. Distribution of cases across schools. The figure shows the fraction of total cases at schools with 1 to 28 cases.

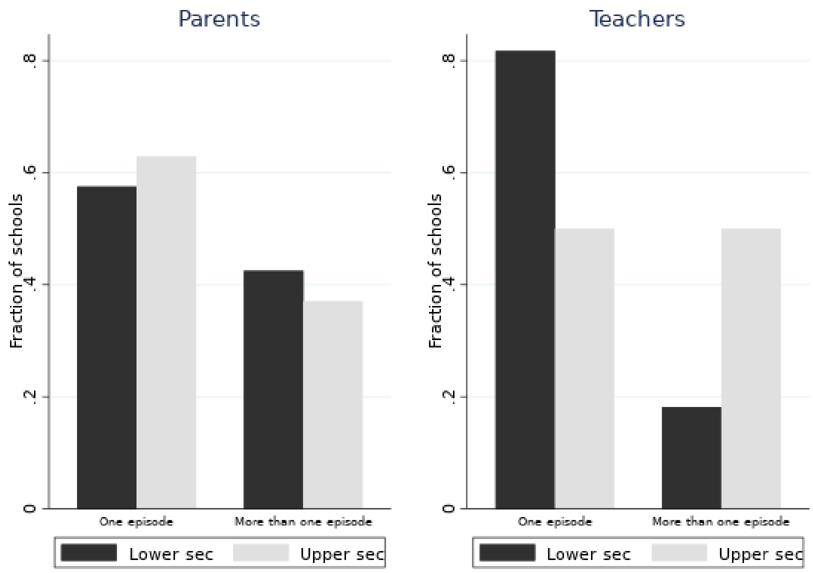


Fig. S8. Episodes of cases within schools. The figure shows the fraction of schools with at least two cases which had all cases in one week or adjacent weeks and the fraction of schools with cases at least one week apart.

Table S1. Impact of exposure to open schools on PCR tests and severe COVID-19 diagnoses

	Parents		Teachers		Teachers' partners	
	OLS (cases/1000)					
	PCR	Severe cases	PCR	Severe cases	PCR	Severe cases
Open school	1.05**	-0.21	2.81***	0.84***	1.47**	0.08
	(0.43)	(0.18)	(0.59)	(0.28)	(0.71)	(0.31)
Mean dep. var.	6.37	1.40	2.96	0.96	5.10	1.01
Obs.	166,630	166,719	72,946	72,976	47,383	47,413
	Logit (odds ratios)					
	PCR	Severe cases	PCR	Severe cases	PCR	Severe cases
Open school	1.17**	0.84	2.01***	2.15***	1.29*	1.09
	[1.03,1.32]	[0.64,1.11]	[1.52,2.67]	[1.41,3.29]	[1.00,1.67]	[0.62,1.92]
Obs.	163,195	150,571	70,151	62,249	44,025	34,563

Note: $***p < 0.01$, $**p < 0.05$, $*p < 0.1$. Standard errors in parenthesis clustered the at the household level for parents and school level for teachers and partners. "Open school" indicates exposure to lower-secondary schools. Severe cases include COVID-diagnoses registered at hospital or as death. The effects are estimated using linear probability models (OLS) and logistic regressions (Logit).

Table S2. SARS-CoV-2 among lower primary, upper primary, and lower secondary teachers relative to upper secondary teachers (OLS)

	PCR	Healthcare
Lower primary	1.66***	0.70**
	(0.53)	(0.34)
Upper primary	2.19***	1.24***
	(0.54)	(0.37)
Lower secondary	2.85***	1.44***
	(0.59)	(0.35)
Mean dep. var.	2.96	1.61
Obs.	137,213	137,272

Note: $***p < 0.01$, $**p < 0.05$, $*p < 0.1$. Standard errors in parenthesis are clustered at the school level for teachers. Upper secondary teachers are used as the reference category. All covariates included. The results are estimated using linear probability models (OLS).

Table S3. Main results for parents, teachers & partners - when including and excluding controls. Outcome: Positive PCR tests per 1000

	Parents (main)		Parents (all)		Teachers		Partners	
	Controls	Excl. controls	Controls	Excl. controls	Controls	Excl. controls	Controls	Excl. controls
Open school	1.05**	1.01**	1.09***	1.02**	2.81***	2.94***	1.47**	1.58**
	(0.43)	(0.43)	(0.42)	(0.42)	(0.59)	(0.58)	(0.71)	(0.71)
Mean dep. var.	6.37	6.37	7.58	7.58	2.96	2.96	5.10	5.10
Obs.	166,630	166,630	205,843	205,843	72,946	72,946	47,383	47,383

Note: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. Standard errors in parenthesis are clustered at the household level for parents and school level for teachers and partners. “Open school” is defined as exposure to lower secondary school. “Excl. controls” indicates a regression without covariates except for age group effects and sex. The results are estimated using linear probability models (OLS).

Table S4. Robustness tests for parents. Outcome: Positive PCR tests per 1000.

	No indep.	No voc.	Alt. exposure	Pooling 7–12	Pooling 8–11
Open school	1.33***	0.64			
	(0.46)	(0.53)			
Open school*			0.98***	0.20	0.79**
			(0.34)	(0.26)	(0.31)
Mean dep. var	7.15	7.50	6.73	7.56	7.31
Obs.	150,326	124,527	327,209	480,291	322,446

Note: ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. Standard errors in parenthesis clustered at the household level. "Open school" is defined as having the youngest child in school year 9 relative to school year 10. "Open school*" is an indicator for living in a household with a child in lower secondary school (see online supplement for details on sample restriction). In "Alt. exposure" we an alternative measure of exposure, and control for having a child in year 11 or 12. The results are estimated using linear probability models (OLS).

Table S5. Robustness checks for teachers and teachers' partners. Outcome: Positive PCR tests per 1000

	Teachers		Teachers' partners	
	Excl. indep. schools	Excl. partner in healthcare	Excl. indep. schools	Excl. healthcare
Open school	2.63***	2.76***	1.64**	1.57**
	(0.63)	(0.59)	(0.77)	(0.64)
Mean dep. var.	2.96	2.83	5.10	2.78
Obs.	65,119	66,828	42,656	41,363

Note: $***p < 0.01$, $**p < 0.05$, $*p < 0.1$. Standard errors in parenthesis clustered the at the school level. "Open school" is defined as being a teacher or a teachers' partner at the lower secondary level. The results are estimated using linear probability models (OLS).

Table S6. Parents - Controlling for household size

	OLS		Logit	
	PCR	Healthcare	PCR	Healthcare
Open school	1.04**	-0.18	1.17**	0.93
	(0.43)	(0.26)	(0.07)	(0.09)
Mean dep. var.	6.37	2.74		
Obs.	166,630	166,719	163,195	163,155

Note: ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. Standard errors in parenthesis clustered the at the household level. "Open school" is defined as having the youngest child in school year 9 relative to school year 10. The results are estimated using linear probability models (OLS) and logistic regressions (Logit).

Table S7. Robustness check - different cutoff dates for the pre-period. Outcome: Positive PCR tests per 1000

	Parents		Teachers		Teachers' partners	
	OLS (cases/1000)					
	March 25	April 16	March 25	April 16	March 25	April 16
Open school	1.16***	0.87**	2.81***	2.44***	1.43**	1.37**
	(0.43)	(0.40)	(0.59)	(0.55)	(0.73)	(0.69)
Mean dep. var.	6.54	5.74	2.96	2.66	5.32	4.59
Obs.	166,630	166,630	72,946	72,946	47,383	47,383
	Logit (odds ratios)					
	March 25	April 16	March 25	April 16	March 25	April 16
Open school	1.18***	1.16**	2.01***	1.96***	1.27*	1.30*
	[1.04,1.33]	[1.01,1.32]	[1.52,2.67]	[1.46,2.64]	[0.99,1.64]	[0.99,1.71]
Obs.	163,233	162,491	70,151	69,732	44,035	42,948

Note: $***p < 0.01$, $**p < 0.05$, $*p < 0.1$. Standard errors in parenthesis are clustered at the school level for teachers and their partners, at the household level for parents. "March 25" refers to moving the start of the investigation period to that date. Similarly, "April 16" moves the date to April 16. "Open school" is defined as having the youngest child in school year 9 relative to school year 10. The results are estimated using linear probability models (OLS) and logistic regressions (Logit).

Table S8. Heterogeneous treatment for teachers, teachers' partners, and parents. Outcome: Positive PCR tests per 1000

	Parents		Teachers		Teachers' partners	
Open school	1.07**	0.72	3.05***	2.86***	1.83**	1.03
	(0.46)	(0.63)	(0.68)	(0.89)	(0.77)	(1.01)
Densely populated district × Open school	0.09		-0.94		-1.50	
	(1.17)		(1.28)		(1.92)	
High pre-closure spread × Open school		0.71		-0.07		1.00
		(0.85)		(1.17)		(1.44)
Mean dep. var.	6.37	6.37	2.96	2.96	5.10	5.10
Obs.	166,425	166,425	72,942	72,946	47,383	47,383

Note: $***p < 0.01$, $**p < 0.05$, $*p < 0.1$. Standard errors in parenthesis are clustered at the school level for teachers and their partners, at the household level for parents. "Open school" is defined as having the youngest child in school year 9 relative to school year 10. Densely populated districts are above the 75th percentile in the distribution of population density. High pre-closure spread is defined as above 12 detected cases per 100 000 inhabitants (Stockholm, Uppsala, Ostergotland, Skane, Sormland and Jonkoping). The results are estimated using linear probability models (OLS).

Table S9. Students under age 18. Outcome: Positive PCR tests per 1000

	OLS (cases/1000)	Logit (odds ratios)
School year 7	-0.08	0.86
	(0.13)	[0.51,1.46]
School year 8	-0.17	0.70
	(0.13)	[0.40,1.22]
School year 9	-0.07	0.89
	(0.13)	[0.52,1.52]
Mean dep. var.	0.53	
Obs.	224,450	154,459

Note: $***p < 0.01$, $**p < 0.05$, $*p < 0.1$. Standard errors in parenthesis clustered at the school level. 95% confidence intervals in brackets are shown for the odds ratios."School year ..." is in relation to school year 10 (reference category). The results are estimated using linear probability models (OLS) and logistic regressions (odds ratios).

Table S10. COVID-19 cases, patients and deaths by age group

Age group	Cases	Cases ex. health	Deaths	Deaths ex. health	CFR (%)	CFR ex. health	# patients with diagnosis	# patients in hospital
0–6	152	152	1	1	0.66	0.66	132	67
7–16	457	457	0	0	0.00	0.00	230	94
17–19	614	611	0	0	0.00	0.00	230	84
20–29	5730	3204	7	7	0.12	0.22	2114	784
30–39	7396	3544	13	11	0.18	0.31	3185	1456
40–49	8586	4262	40	36	0.47	0.84	3997	1930
50–59	9978	5241	134	122	1.34	2.33	5275	3216
60–69	6463	4113	346	336	5.35	8.17	4666	3461
70–79	4792	4671	1112	1102	23.21	23.59	4756	3902
80–	9314	9301	3749	3741	40.25	40.22	6050	5151
Total	53482	35556	5402	5356	10.10	15.06	30635	21045

Note: Test date until June 15, 2020. Deaths reported until July 25 for cases tested until June 15. ”ex. health” means that healthcare and care workers are dropped (occupational codes 15, 22, 32, 53). CFR refers to the implied Case Fatality Rate.

Table S11. Occupations ranked by incidence of positive PCR-tests (lowest to highest incidence)

Rank	Occupation title (SSYK3)	Cases/1000	Occ. size
1	Specialists within environmental and health protection	1.15	8690
2	Mixed crop and animal breeders	1.15	7807
3	Animal breeders and keepers	1.37	15315
4	Museum curators and librarians and related professionals	1.56	10931
5	Architects and surveyors	1.72	12218
6	Mathematicians, actuaries and statisticians	1.76	2267
7	ICT architects, systems analysts and test managers	1.93	127722
8	Electronics and telecommunications installers and repairers	1.96	10711
9	Library and filing clerks	1.98	3533
10	Biologists, pharmacologists and specialists in agriculture and forestry	2.00	7006
11	Sheet and structural metal workers, moulders and welders, and related workers	2.08	25959
12	University and higher education teachers	2.08	37457
13	Designers	2.11	16579
14	Wood processing and papermaking plant operators	2.19	15986
15	Ships' deck crews and related workers	2.22	1350
16	Engineering professionals	2.26	95496
17	Market gardeners and crop growers	2.27	23319
18	Other service related workers	2.31	3892
19	Marketing and public relations professionals	2.36	39061
20	Metal processing and finishing plant operators	2.37	16441
21	Carpenters, bricklayers and construction workers	2.44	106364
22	Mobile plant operators	2.46	35715
23	Financial and accounting associate professionals	2.49	57856
24	Tax and related government associate professionals	2.50	44063
25	Recycling collectors	2.55	8634
26	Painters, Lacquerers, Chimney-sweepers and related trades workers	2.57	26114
27	Research and development managers	2.58	6192
28	Construction labourers	2.59	6948
29	Electrical equipment installers and repairers	2.60	38434
30	ICT operations and user support technicians	2.61	44879
31	Berry pickers and planters	2.63	3045
32	Physicists and chemists	2.63	6462
33	Forestry and related workers	2.64	5690
34	Creative and performing artists	2.64	12491
35	Accountants, financial analysts and fund managers	2.65	49484
36	Culinary associate professionals	2.72	4046
37	Broadcasting and audio-visual technicians	2.76	4350
38	Other stationary plant and machine operators	2.76	7237
39	Physical and engineering science technicians	2.77	104914
40	Information, communication and public relations managers	2.78	4313
41	Legal professionals	2.80	22498
42	Roofers, floor layers, plumbers and pipefitters	2.90	35526
43	Commissioned armed forces officers	2.91	1032
44	Postmen and postal facility workers	2.91	15781
45	Precision-instrument makers and handicraft workers	2.94	4762
46	Client information clerks	2.96	60517
47	Production managers in manufacturing	2.98	16439
48	Financial and insurance managers	3.00	4995
49	Printing trades workers	3.05	7542
50	Insurance advisers, sales and purchasing agents	3.06	132527
51	Machine operators, textile, fur and leather products	3.07	5538
52	Ship and aircraft controllers and technicians	3.07	5535
53	Real estate and head of administration manager	3.08	3898
54	Event seller and telemarketers	3.09	9073
55	Armed forces occupations, other ranks	3.12	5448
56	Information and communications technology service managers	3.22	11185
57	Blacksmiths, toolmakers and related trades workers	3.22	49318
58	Machinery mechanics and fitters	3.23	59063
59	Upper secondary school teachers	3.24	32130
60	Sports, leisure and wellness managers	3.26	1533
61	Shop staff	3.27	194098
62	Waiters and bartenders	3.28	21963

63	Dockers and ground personnel	3.29	9415
64	Production managers in construction and mining	3.30	17554
65	Finance managers	3.36	17544
66	Train operators and related workers	3.38	5626
67	Supply, logistics and transport managers	3.39	11223
68	Administrative and specialized secretaries	3.43	17491
69	Wood treaters, cabinet-makers and related trades workers	3.46	11287
70	Stores and transport clerks	3.54	93586
71	Administration and planning managers	3.54	10438
72	Sales and marketing managers	3.57	30809
73	Photographers, interior decorators and entertainers	3.59	9198
74	Vocational education teachers	3.64	9888
75	Authors, journalists and linguists	3.67	16615
76	Machine operators, rubber, plastic and paper products	3.67	13342
77	Business services agents	3.69	32825
78	Process control technicians	3.69	18686
79	Elected representatives	3.74	1070
80	Machine operators, food and related products	3.77	14866
81	Organisation analysts, policy administrators and human resource specialists	3.79	112865
82	Lower primary school teachers	3.81	31992
83	Assemblers	3.88	55141
84	Cashiers and related clerks	3.97	11339
85	Athletes, fitness instructors and recreational workers	3.98	26376
86	Manufacturing labourers	4.05	10383
87	Hotel and conference managers	4.05	1483
88	Construction and manufacturing supervisors	4.05	24431
89	Other services managers not elsewhere classified	4.08	7103
90	Mining and mineral processing plant operators	4.14	7980
91	Butchers, bakers and food processors	4.14	8215
92	Office assistants and other secretaries	4.16	168407
93	Architectural and engineering managers	4.18	11232
94	Croupiers, debt collectors and related workers	4.22	2132
95	Human resource managers	4.27	8663
96	Preschool managers	4.28	4677
97	Retail and wholesale trade managers	4.46	10304
98	Cooks and cold-buffet managers	4.57	40728
99	Heavy truck and bus drivers	4.61	75333
100	Administration and service managers not elsewhere classified	4.70	23612
101	Childcare workers and teachers aides	4.70	124777
102	Managing directors and chief executives	4.71	20381
103	Teaching professionals not elsewhere classified	4.75	36664
104	Upper primary school teachers	4.82	29850
105	Tailors, upholsterers and leather craftsmen	4.85	3298
106	Primary and secondary schools and adult education managers	4.93	10557
107	Building caretakers and related workers	4.93	47028
108	Cabin crew, guides and related workers	4.96	8469
109	Religious professionals and deacons	4.98	3615
110	Fast-food workers, food preparation assistants	5.04	71276
111	Newspaper distributors, janitors and other service workers	5.12	41773
112	Cleaners and helpers	5.16	85416
113	Other surveillance and security workers	5.46	36460
114	Washers, window cleaners and other cleaning workers	5.49	7835
115	Legislators and senior officials	5.49	2915
116	Hairdressers, beauty and body therapists	5.53	21344
117	Restaurant managers	5.64	8332
118	Driving instructors and other instructors	5.8	7409
119	Lower secondary school teachers	5.83	37894
120	Social work and counselling professionals	6.69	46161
121	Machine operators, chemical and pharmaceutical products	6.9	5072
122	Police officers	8.08	16219
123	Social work and religious associate professionals	8.6	22084
124	Education managers not elsewhere classified	8.85	1243
125	Car, van and motorcycle drivers	9.03	19594

Note: Incidence (cases per 1000) of detected SARS-CoV-2 by 3-digit occupational codes (SSYK2012) until June 15, 2020. Ages 25–65, only occupations with at least 1000 employees reported. Healthcare occupations are excluded from the ranking. Teachers at different levels are identified using the Teacher Register and not by using SSYK codes 233 (compulsory school teachers) and 234 (upper secondary school teachers).

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