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COVID-19 AND SCHOOL CLOSURES*

Helena Svaleryd[†] and Jonas Vlachos[‡]

Abstract

To reduce the spread of COVID-19, schools closed to an unprecedented degree in the spring of 2020. To varying extent, students have moved between in-person and remote learning up until the spring of 2021. This chapter surveys the literature on the implications of school closures of primary to upper-secondary schools for virus transmission, student learning, and mental health among children and adolescents in high-income countries. Subject to severe methodological challenges, most studies indicate that the initial school closures at least to some extent contributed to a reduction of virus transmission. However, several studies find that schools could reopen safely, especially when substantial within-school preventive measures were implemented and the general level of transmission was moderate. Student age also matters and keeping schools open for younger students contributes less to overall virus transmission. Most studies find that students learned less and that learning inequalities widened when school closed. These patterns are particularly pronounced for younger students who face more challenges adjusting to remote instruction. Essentially nothing can be said concerning the implications for vocational training. High-quality evidence on the impact on mental health is scarce and the results are mixed, but there are some indications that older students coped better with school closures also in this regard. On balance, closing schools for younger students is less well-motivated than for older students.

Index terms

COVID-19, Mental health, School closures, Student achievement, Virus transmission

JEL codes

I12, I21

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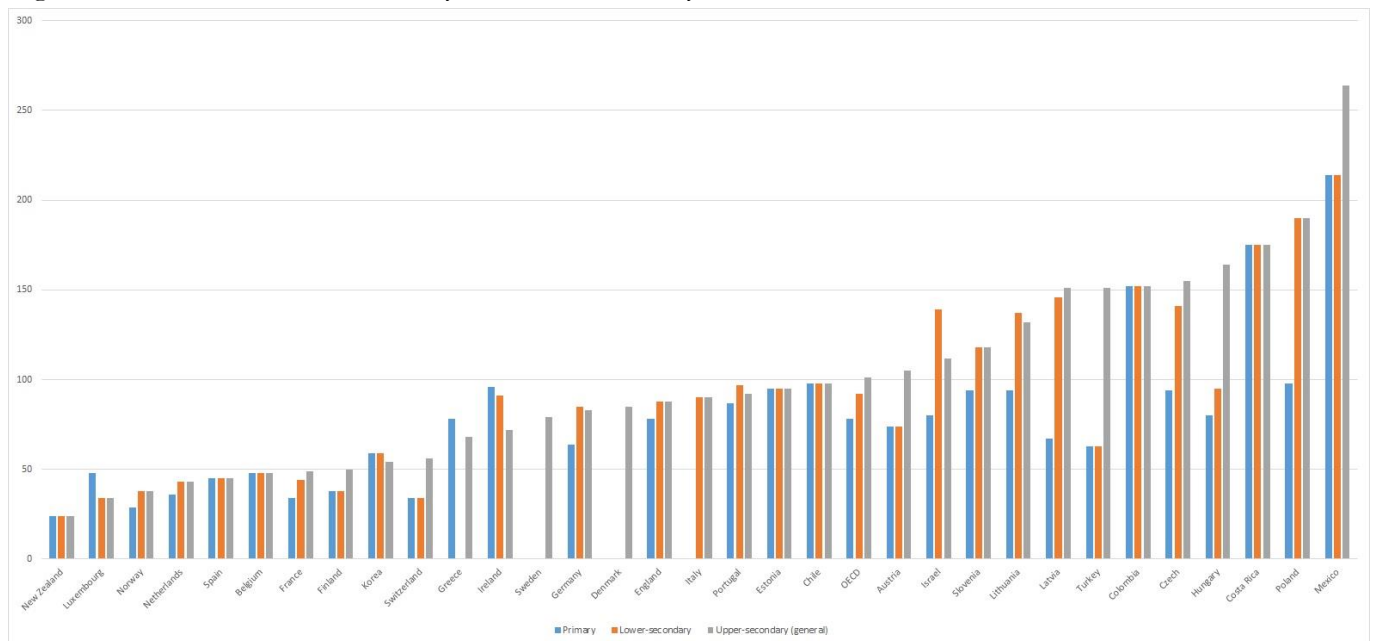
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Introduction

In the attempt to limit the transmission of SARS-CoV-2 and illness due to COVID-19, schools were closed to an unprecedented degree during the spring of 2020. According to UNESCO (2021), school closures affected more than 70 percent of the world's students in mid-April 2020. These dramatic measures in order to combat COVID-19 have potentially had severe detrimental consequences for learning and mental health among students, while their efficiency in reducing the transmission of the virus is not fully clear. This chapter discusses three themes related to school closures during the pandemic among high-income countries. The first is the impact of school closures on the spread of COVID-19. The second is the impact of school closures on student learning, and the third is the impact on student mental health.

The degree to which schools closed during the pandemic varied substantially across countries, regions and grade levels. Figure 1 gives a crude indication of the number of days lost between January 1, 2020 and May 20, 2021, in a selection of countries. As detailed in OECD (2021), there was also a wide variation in the number of days that schools at different levels were partially closed. On average over the period, schools were fully (partially) closed for 101 (67) school days at the upper-secondary level, 92 (43) days at the lower-secondary level, and 78 (41) days at the primary level. In a large majority of countries, students were offered some type of remote learning as a substitute for in-person instruction. National testing and exams were also severely disrupted during the pandemic. According to the OECD, 56 percent of surveyed countries cancelled their standardized assessment in 2020, a fraction that increased to 63 percent in 2021. As national standardized testing was cancelled to such a large extent complicates the assessment of the impact on student learning.

Figure 1. Number of instruction days schools were fully closed 2020 and 2021



Note: Number of school days when schools were fully closed due to the pandemic until May 2021. Source: OECD (2021).

In this chapter, focus lay on empirical studies that attempt to isolate the causal impacts of school closures on relevant outcomes. There are references to modelling studies but then only to highlight certain theoretical concepts and mechanisms. Published studies are preferred but there are some references to working papers

and pre-prints that are deemed to be particularly interesting and useful. No attempt is made to cover the general literature on school closures or online education. The reason to limit the survey to high-income countries is that the infrastructure for handling the transition to online and digital education is more well-developed in this group of countries. Attention is restricted to primary and secondary education (approximately K-12 in an US context) due to the paucity of studies at higher levels of education and the wide differences of childcare policies across countries. Each section of the chapter presents the literature related to the respective topic and ends with a brief discussion. The concluding section attempts to summarize and draw conclusions from this rapidly expanding literature.

1. School closures and the spread of COVID-19

After some initial hesitancy it is now established that children and adolescents can be infected with SARS-CoV-2, can get sick with COVID-19, and can spread the virus to others (CDC 2021; ECDC 2021). Whether or not school closure is an effective tool to reduce the transmission of SARS-CoV-2 is a somewhat different question where the answer crucially depends on the characteristics of the virus and other precautionary measures taken. Epidemiological models based on influenza predict that school closures can be effective if they actually reduce the number of contacts, the reproduction number is relatively low, and the attack rate is higher in children than in adults (Jackson et al. 2014). While it is not obvious that the COVID-19 pandemic could be treated as an influenza, this implies that the impact of school closures depends on the settings in which they occur. In particular, the impact is likely to differ with respect to virus variant dominating, the overall rate of transmission in society, other interventions in place, and precautionary measures undertaken in schools. As in the other areas covered in this chapter, a major empirical challenge is to isolate the impact of school closures from other interventions is that schools in most locations closed early, universally, and in close proximity to a raft of nonpharmaceutical interventions (NPIs). Different interventions are also likely to interact in intricate ways. If, for example, students replace social interactions in school with socializing outside of school, the impact will differ compared to a setting in which out-of-school socializing is limited by other NPIs in place. There is thus hardly any general school closure parameter to be found and this review focuses on the impact across the various settings that have been studied. That children and adolescents usually develop mild symptoms poses another challenge to analyze the impact, in particular during the early stages of the pandemic when testing was scarce.

1.1 Studies on the impact on virus transmission and illness

Several studies on the impact of school closures are correlational, exploiting variation in school-closure policy across time and space on infection rates and health outcomes related to COVID-19. Using cross-country data for 130 countries, Liu et al. (2021a) find that closing schools is one of the NPIs associated with a substantial reduction of the transmission rate. Askitas et al. (2021) reach a similar conclusion using data for an even larger number of countries. Using a similar approach and US state level data, Liu et al. (2021b) reach the conclusion that school closures have a modest, but statistically significant, association with a reduction of the reproduction number. Auger et al. (2020) use state-level US data and find that school closures in the US were temporally associated with a large reduction of COVID-19 incidence and mortality in the initial phase of the pandemic. Rauscher and Burns (2021) reach a similar conclusion by studying the exact timing of school closures at the onset of the pandemic. In order to deal with the endogeneity of school closures, they use matching based on nearest geographic neighbor and propensity scores and find that each day of delay in closing schools was related to a 1.5-2.4 percent higher death rate by mid-June 2020. They further find school closures to be more strongly related to COVID-19 deaths in counties with a high concentration of Black or poor residents. Chernozhukov et al. (2021a) study school closures across US states in a model that allows for dynamic effects and find no impact on transmission rates but a reduction in the mortality rate. Using fixed

effects models at US county level, Courtemanche et al. (2020) find no impact of school closures on transmission rates. Jamison et al. (2021) fail to find an impact on mortality in a study of school closures across 13 European countries while Piovani et al. (2021) find the opposite result in a panel study of 37 OECD countries.

As the authors of the above studies are keenly aware of, they suffer from the problem that closing schools is an endogenous response to the pandemic. In various ways, this is handled by controlling for other NPIs and other local conditions. However, as the variation in the initial closure dates is limited and closures are mostly enforced jointly with other NPIs, it is inherently difficult, even impossible, to isolate the impact of any particular intervention. Vlachos et al. (2021) circumvents these problems by exploiting that Sweden closed its upper-secondary schools in mid-March 2020 while lower-secondary schools remained open. In other regards, families exposed to open and closed schools were subject to the same type of restrictions and faced the same level of virus transmission. Hence, the study can credibly isolate the impact of school closures in a setting of high transmission and with very limited precautions in the schools that were kept open. The study utilizes register data and finds that the incidence of positive test results by mid-June 2020 was 17 percent higher among parents of first-year upper-secondary students than among final-year lower-secondary parents. Given that lower-secondary parents make up approximately 4.5 percent of the total population, the impact on overall transmission from keeping lower-secondary schools open is deemed to be small, especially considering that the estimate captures between-spouse transmission. A caveat to this conclusion is that the full implications for transmission would require modelling of secondary infections outside of the household. The study also finds that lower-secondary teachers had twice the rate of infections and hospitalizations compared to upper-secondary teachers. Spouses of lower-secondary teachers had a 30 percent higher infection rate than upper-secondary spouses. While this is clear evidence that in-person schooling increased infections among teachers, the study cannot distinguish between student-teacher and teacher-teacher transmission. These results are in line with the findings from a similar analysis by Bravata et al. (2021). Using county-level data for the entire US, they find that in-person visits to schools lead to a small increase in COVID-19 diagnoses among households with children relative to households without school-age children. The relative difference between households is larger in low-income counties, counties with a higher disease prevalence, and at later stages of the COVID-19 pandemic. While these studies have a relatively credible design, they focus on within-household transmission and therefore cannot capture the full community impact of school closures. Further, the study from Sweden compares outcomes between households with adolescents and the results may not generalize to settings where school closures affected children in more need of care.

Studying school reopenings rather than school closures potentially suffer from less pronounced endogeneity problems as reopenings often occur in connection to pre-set dates during the school year. Using dynamic county-level panel data, Chernozhukov et al. (2021b) study the period between April and December 2020 and find that an increase in visits to both K–12 schools was associated with a subsequent increase in case and death growth rates. This association was stronger for counties that do not require staff to wear masks at schools. Using school-district data to study the impact of school re-openings in Texas during the fall of 2020, Courtemanche et al. (2021) find that these substantially increased the per capita numbers of new weekly COVID-19 cases and deaths. This was likely facilitated by increased mobility, which could arise both directly in schools but also indirectly through the behaviors of parents or other adults. A county-level panel-data study from Indiana finds a statistically significant but proportionally small association between in-person primary and secondary schooling and an increase in the spread of SARS-CoV-2 cases (Bosslet et al. 2021). In contrast, Goldhaber et al. (2021), use county-level data from Michigan and Wisconsin and find that hybrid or fully in-person instruction was not significantly contributing to COVID spread in communities when there are low or modest pre-existing case rates in the population. Similarly, Harris et al. (2021) use weekly county-level panel data from most of the US and find that the re-opening to in-person schooling school was not

associated with an increase in COVID-19 hospitalizations in counties where pre-opening level of hospitalizations was low. In counties with higher rates of hospitalizations, the results are inconclusive. As the initial level of transmission was high in Texas, these results are not necessarily contradictory. In a nation-wide study of US counties that distinguishes between remote, hybrid and in-person schooling, Ertem et al. (2021) use an event study approach to study the 12 weeks after school opening (July–September 2020). In most regions, they find no association between infection rates and school opening mode during the initial weeks of the school year. In the South, however, there was a significant and sustained increase in infection rates among counties that opened for in-person learning compared to those that were fully remote or hybrid, driven by cases in 0–9 year olds and adults. They cannot fully explain the reason for the different effects across regions, but in the South infection control measures both inside and outside of school were limited. A somewhat different answer to the question of instruction mode matters for virus transmission, is reached by Reinbold (2021) who uses a synthetic control approach to study the after-summer school reopenings in Illinois. The results show that counties in which a majority of students had fully remote or hybrid instruction experienced significantly fewer new cases compared to majority in-person counties. A caveat to this result is that the study does not control for pre-existing transmission levels which in turn may have influenced the mode of instruction.

In a study that exploits differences in the timing of school reopenings after the 2020 summer break in Italy (the Sicily region), Amodio et al. (2021) find that they were associated with an increase in the number of cases. Accounting for the dynamic process, they estimate that between 14–26 percent of total cases during the fall of 2020 ultimately can be attributed to schools. To the contrary, Ispording et al. (2021) exploit that German schools reopened in a staggered way after the summer break in 2020 and find a negative but insignificant impact on the number of confirmed cases. The authors do not find indications that changes in mobility patterns can account for the result. However, based on patterns of web-searches they speculate that changes in parental containment measures due to the high opportunity costs of children in quarantine could be an important mechanism. Similar results are found in von Bismarck-Osten et al. (2021) who use variation in the start and end dates of the summer and fall school holidays across the German federal states to show that neither the summer closures nor closures during the fall had a significant containing effect on the spread of SARS-CoV-2 among children or a spill-over effect on older generations. There is also no indication that the return to school at full capacity after the summer holidays increased infections among children or adults. Rather, they find that the number of children infected increased during the last weeks of the summer holiday and decreased in the first weeks after schools reopened, a pattern potentially due to travel returnees before school start. An open question regarding these studies is how well closures and reopenings due to school breaks generalize to school closures during other periods. Precautionary measures in German schools were strict with mandatory masks, fixed-group teaching, and infections led to rapid testing and quarantining of contact persons. As survey evidence from the US shows that the risk associated with open schools depends on the mitigation measures taken in schools and that it increases in student age (Lessler et al. 2021), this can potentially explain differing results between studies. That student age is an important factor is corroborated by Aiano et al. (2021) who document that the reopening of schools in England was associated with a more and larger outbreaks among secondary schools than among primary schools.

1.2 Discussion

The question of child infection and transmission was much discussed at the onset of the pandemic but there is by now clear evidence that children do get infected and do transmit SARS-CoV-2. The evidence regarding the role of school closures and school openings on the transmission of the virus is, however, mixed. Several studies do find reduced community transmission from closing schools but there are also studies reporting no effects. As noted in the above discussion as well as in other reviews (e.g. Walsh et al. 2021), studies of school closures are at the risk of confounding and collinearity from other NPIs implemented around the same time

as school closures, and it is fair to say that the effectiveness of closures to reduce virus transmission remains uncertain. How school policies affect transmission also depends on the level of community transmission and there are indications that reopening schools to in-person instruction does not significantly contribute to COVID transmission in communities when there are low or modest levels of transmission. As the level of community transmission is likely to affect both formal precautionary measures and endogenous behavioural responses, some caution is warranted regarding this conclusion, however. More certain are the indications that mitigation measures within schools can substantially reduce transmission and that the risks related to keeping schools open increase in student age. Further support for age being an important factor is supported by the review by Irfan et al. (2021) who argue that the evidence from school-based studies demonstrate it is largely safe for children (<10 years) to be at schools, while older children (10-19 years) might facilitate transmission. A potentially important caveat that applies to the results reported here is that newer variants of the virus (e.g. the Delta variant) may affect the role of schools in transmitting Covid-19.

2. School closures and student achievement

There are good reasons to expect student learning to be negatively affected by the school closures that have been implemented during the pandemic. A substantive body of research shows that students learn by attending school and hence learn less when schools are closed. However, as various forms of online and digital education were introduced as a substitute to traditional schooling, the research showing negative effects by remote learning, in particular among students from socially disadvantaged backgrounds, is more relevant (Escueta et al. 2020). Agostinelli et al. (2020) present a calibrated model that highlights several of the channels through which the pandemic and the switch to online education may affect learning and human capital formation. The model is calibrated for students in grades 9 to 12 but the general mechanisms are likely to have bearing also for younger students. Online learning is expected to be less efficient than traditional classroom education and, in addition, the model assumes that social interactions in the school environment are replaced by interactions in the residential neighborhood. This affects whom students interact with and also contributes to making interactions less oriented towards school work. Online learning places demands on the home environment and the capacity to offer help and support differs widely between households. Knowledgeable parents who are teleworking from home can offer their children assistance and support to a much greater extent than parents for whom the opposite applies. That opportunities for telework are larger among well-educated and high-income earners (Adams-Prassl et al. 2020) contributes to the inequalities in the home environment. The model concludes that all these channels contribute to less learning on average and a widening of the learning gap between socially advantaged and disadvantaged students. It is important to stress that these conclusions are derived from a parameterized theoretical model and not from empirical estimates of actual outcomes. The same caveat applies to a related model-based study by Fuchs-Schündeln et al. (2020) which draws similar conclusions as Agostinelli et al. (2020) when analyzing the long-term economic consequences of learning losses induced by school closures. The same applies to all studies using results from previous research on the impact of school closures, student absenteeism, and online education to predict the impact of school closures during the pandemic. In short, school closures and the move to online education is expected to result in a lower mean and a greater dispersion of student achievement and attainment (Dorn et al. 2020; Haack and Lefebvre 2020; Wyse et al. 2020; Kaffenberger 2021; Blasko et al. 2021).

2.1 Impact on student learning

Few studies are able to credibly identify the causal effect of school closures on student learning. In particular, most studies cannot differentiate between the general impact of the pandemic from the impact of school closures per se. This is a difficulty that is shared with studies on mental health and - to some extent - with studies on the impact of school closures on virus transmission. A further difficulty is that exams and

standardized tests that are normally used to track student achievement were canceled in several countries during the pandemic.

In countries where national tests were held or exams were taken, it is possible to compare the results during the pandemic with the results from previous years. This approach is used by Maldonado and De Witte (2021) who compare the results on standardized tests among Belgian 12-year-old students (grade 6) at the end of the spring term in June 2020 with the results from the same tests during 2015-2019. At that point, schools had been closed for nine weeks starting in mid-March, partially open from mid-May, and fully open from early June. They analyze five different subjects and find that the results fell by between 0.12 to 0.3 standard deviations depending on the subject and the exact empirical specification. For their preferred specifications, the decrease relative to previous years was 0.17 standard deviations in mathematics and 0.19 standard deviations in Dutch. In order to account for potential changes in student composition, they control for test scores from grade 4 and various student and school characteristics. In line with the theoretical predictions, they further find that learning inequalities increased both within and between schools.

Similar results are found by Engzell et al. (2021) who exploit that Dutch students in ages 8-11 (grades 4-7) take standardized tests in core subjects both in the middle and at the end of the school year. They can thus use a difference-in-difference approach to estimate the difference between mid- and end-year test results 2020, after a school closure period of 8 weeks starting in mid-March, relative to the same difference during 2017-19. Using a composite measure of test scores, they find a decrease in student achievement by 0.08 standard deviations. Given the relatively brief period of school closures, this amounts to students essentially making no progress at all during the closure. They further find smaller learning losses among students with highly educated parents and thus that the school closure increased the socio-economic gradient in learning outcomes. Apart from this important heterogeneity, the impact is relatively uniform across subjects, age groups, student sex, and student prior performance. A still unpublished study uses a similar approach to track student progress until March 2021, following a second period of school closures in the Netherlands (Haerlermans et al. 2021). The findings indicate learning losses of 0.06 (spelling), 0.12 (maths), and 0.17 (reading) standard deviations and thus no catch-up since the first closure. Again, learning losses are substantially larger for students with a low socioeconomic background. However, these results are sensitive to an adjustment for the delay in standardized testing that occurred due to the second lockdown and should be regarded as preliminary.

A Norwegian study finds that first grade students' handwriting suffered substantially in fluency (sd 0.27) and quality (sd 0.6) compared to the pre-pandemic cohort. Students' attitude towards handwriting was also modestly worse after the 7 week closure (sd 0.11) and the losses were larger among non-native speakers. Using data from annual standardized tests in mathematics and reading, taken in September by students in school grade 5 (age 11), a preliminary German study reports a decrease of between 0.03 and 0.09 standard deviations in reading and mathematics in 2020 compared to previous years (Schult et al. 2021). However, they do not find a consistent pattern with respect to high or low-performing students. In reading comprehension, the results fell more among strong students whereas the opposite was the case in mathematics. Among Italian 8-year-olds, Contini et al. (2021) find an average decrease in mathematics of 0.19 standard deviations compared to the previous cohort. The decrease is of similar magnitude among students with high- and low-educated parents, but they find that high-performing students and girls with less-educated parents were harmed the most. They also find evidence of substantial attrition among low-performing students at the test taken during the evaluation. Such attrition is a plausible concern for most studies and unless properly handled it will result in an underestimate of the learning loss during school closures.

Results from several studies using traditional standardized tests are thus more or less in line with the theoretical predictions. However, two Dutch studies using achievement estimates from online learning tools raise some concerns regarding the generalizability of the above results. In an unpublished study, Meeter

(2021) uses data from adaptive practice software and finds increases in mathematics achievement among Dutch students. The study tracks students before, during, and after the lockdown period until the end of the school year and compares patterns of usage and achievement with the same period during the previous year. Usage of the online tool increased substantially during the period of school closure and remained high in the post-closure period. The study targets students in ages 6-10 (grades 2-6) and the improvements were particularly large among younger students, among initial low-performers, and at schools with socially advantaged student populations. A related Dutch study (van der Velde et al. 2021) uses an online adaptive learning tool for foreign languages (English and French) among students in age groups 12-16 (grades 7-10) and finds that student progress was basically unaffected by the school closure. However, there are some indications that progress increased among students at the highest educational track. Improved learning outcomes compared to the previous year are also found for Germany in a study among students that used an online learning tool for mathematics (Spitzer and Musslik 2021). The improvements were found to be larger among initially weak students. A Swiss study uses data from a computer-based formative assessment tool in mathematics and language that was used prior to the pandemic (Tomasik et al. 2021). They compare learning gains during the 8 weeks lockdown with the gains for the 8 preceding weeks. Among younger students (9-11 years) learning was substantially slower during the period of school closure and the dispersion of learning gains increased. Among older students (12-15 years) the differences before and after closure were not statistically significant.

Since some of these studies are conducted in a similar context as Maldonado and De Witte (2021) and - in particular - Engzell et al. (2021), the question arises why they reach such different conclusions. Meeter (2021) suggests that there may have been less focus on preparation for the standardized testing format than usual. This would imply that the learning losses suggested by studies that rely on such tests may be overstated. Alternatively, the online tools may capture a different and more narrow skill set than the standardized tests. In particular, standardized tests may require better reading comprehension. Another possibility is that the gains at least partially reflect increased practice in using the online tools. If this is the case, studies that rely on such tools may understate the actual learning loss. Further, it should be stressed that results for students using online learning tools can only be estimated for students who actually use them. If the tools are used only by a fraction of students, results that these students benefit from their use do not necessarily contradict results based on test scores for the overall student population. Based on the above studies, it is not possible to draw any firm conclusions beyond that online learning to some extent can compensate for learning losses induced by school closures.

Turning to Anglo-Saxon countries, an analysis from the first years of elementary schooling (age 6-7) in England finds that achievement in reading and mathematics had decreased by between 0.13 and 0.24 standard deviations depending on the subject and exact grade level (Rose et al. 2021). They also report some, but somewhat inconsistent, indications of a widening achievement gap between advantaged and disadvantaged students. An Australian study of 9 and 10-year-olds (grades 3 and 4) who experienced an 8-10 week period of school closure, finds a small and statistically insignificant increase in both mathematics and reading scores (Gore et al. 2021) but this result hides some important heterogeneities. In particular, results fell at schools serving socially disadvantaged students while the opposite occurred in socially advantaged schools. Schools in the US have been closed to various degrees but usually for substantially longer periods than in most of Europe. Using data for approximately 5.5 million students, Lewis et al. (2021) find that students across grades 3 to 8 (9 to 14 years old) made non-trivially lower gains in reading and math gains during 2020-21 compared to previous years. The relative decline was larger in math than in reading and larger among disadvantaged as well as among younger students. Similar results are reported for students across 22 states by Dorn et al. (2020) in an evaluation of learning in mathematics and reading among students 6-11 years old (grades K-5). Relatively similar results are reported in Pier et al. (2021) who use a similar empirical strategy but a wider set of assessment tools to analyze learning outcomes among 10-14-year-olds (grades 4-8) in mathematics and

English in California. They find substantial learning losses during the pandemic compared to previous years. Losses were of similar magnitude for both subject areas but larger for groups of relatively disadvantaged students. In a review of the US evidence to date, West and Lake (2021) conclude that learning during the pandemic slowed substantially and more so in mathematics than in reading, more among younger students as well as among disadvantaged students and minorities (except for Asian-Americans). The above studies cannot differentiate between the impact of different forms of instruction during the pandemic, but Kogan and Lavertu (2021) make progress in this regard. They analyze the impact on learning in English and mathematics in Ohio among students at different grade levels and quite consistently find that learning lagged more in mathematics than in English, more among socially disadvantaged and academically weak students. Of particular interest is that they find smaller learning losses among students who experienced more in-person schooling.

2.2 Evidence on educational inputs

A serious limitation of most studies on actual achievement is the possibility of non-random attrition among test takers during the pandemic. Such attrition will bias estimates of both average achievement and of learning inequalities. Another concern is that various forms of examinations and testing were cancelled, hence making comparisons to previous years difficult or impossible. A number of studies therefore approach the issue by analyzing various inputs into education rather than direct achievement data. For obvious reasons, the results from this literature cannot be easily compared across studies.

One of the most central inputs to education is the time spent on school work and studying. A German study uses detailed time-use information from a survey in June 2020 where parents were asked to provide information on students' activities both before and during the school closures (Grewenig et al. 2021). They find a 50 percent decrease in average daily learning time, and a larger reduction among low- than among high-achievers (4.1 hours per day vs 3.7). Low-achievers also spent disproportionately more time on activities considered detrimental to child development, such as playing computer games and watching TV. A follow-up survey conducted during the second wave of school closures in early 2021 finds that learning time increased compared to the first wave of school closures but remained low (Werner and Woessmann 2021). There are some indications that the gap in learning time between high- and low-achievers closed somewhat during the second period, but the gap in learning efficiency (as judged by parents) remained large. Learning time was increasing with daily online class instruction, but not with other school activities or home inputs. Similar patterns are found in a time-use study from England (Andrew et al. 2020). The study finds that learning time decreased during the first period of school closures and that there were strong heterogeneities related to family income with respect to the at-home learning experiences. Despite schools largely being open during the fall of 2020, a later analysis finds that British students lost approximately half of all school days between March 2020 and March 2021 due to closures and increased absences (Major et al. 2021). Using data from recurring parental surveys, they estimate that time in school was only partially replaced by at-home learning. They also find clear socioeconomic differences in how much learning time was lost.

In the US, Bacher-Hicks et al. (2021) find that web searches for online learning tools geared both towards students and parents increased substantially more in high socioeconomic areas. In line with this, Chetty et al. (2020) document that students from high socioeconomic areas rebounded quite rapidly after an initial drop regarding the number of online math assignments students completed. The catch-up was substantially slower in more disadvantaged areas. Tracking at-home learning activities between April and July 2020, Bansak and Starr (2021) find that parents and children allocated more time to educational activities at home when their school systems provided more inputs. Less-educated parents spent less time helping their children with school work and the patterns suggest that this can largely be attributed to differential access to live online classes.

From the Netherlands, Bol (2020) reports that children from a socially advantaged background received more at-home help with their school work and learning during the first period of school closure, mainly because their parents felt more capable of providing assistance. Parents also found it easier to assist girls than boys, and that online learning gave better support for academic than vocational study tracks. In Switzerland, learning time decreased substantially among secondary students when schools closed, but no substantive differences could be found by gender or socioeconomic background (Grätz and Lipps 2021). In Denmark, the socioeconomic gradient in library loans increased during the pandemic, plausibly indicating an increased gradient in reading habits (Jaeger and Blaabaek 2020). Using data from a Danish reading app, Reimer et al. (2021) find that the social gradient in reading increased, but only during the period of full school closure. A British study finds the transfer to online teaching to have been more challenging in science than in mathematics and English (Canovan and Fallon 2021). That schools prioritized core subjects, logistical challenges, and parents being less able to provide at-home support in the sciences all contributed to this pattern and the problems were particularly large in socioeconomically disadvantaged areas. A Swedish study of upper-secondary students finds that not only does access to digital tools and parental support differ between academically strong and weak students, but also that the latter group finds it more difficult to concentrate using such tools (Bergdahl et al., 2020).

2.3 Discussion

Most evidence supports the prediction of substantial average learning losses and widening learning inequalities as a consequence of the school closures during the pandemic. This applies both to studies of test scores and the amount of time spent studying. The available evidence also indicates that learning losses may be more substantial among younger students, suggesting that they are less capable of handling remote learning. Some studies that are based on online evaluations that point in a different direction but how well such evaluations capture actual learning compared to standard testing is an open question. There are also issues concerning the representativeness of samples used in most studies, particularly among those that use online evaluations. Few studies manage to distinguish between the learning experience from different modes of instruction, but those that do indicate that a higher degree of in-person learning during the pandemic reduces the learning loss. Most studies focus on learning in core subjects which is a minor limitation at lower ages but more severe among older students where the subject matter in non-core and practical subjects is more substantial. The scant evidence available makes it plausible that learning losses in such subjects are more severe than in core subjects and the long-run repercussions of this are basically unknown. A related and major limitation is the lack of studies learning losses in vocational training. An exception is Goller and Wolter (2021) who find that applications for apprenticeships declined substantially in Switzerland.

3. School closures and student mental health

School closures may have implications for mental health and well-being of children and adolescents. Schools are not just places where students learn academic skills, but also places for social interaction and providers of other functions potentially affecting mental health. Moving to remote learning disrupts the normal daily interactions with classmates and school personnel, which can cause increased mental stress. Research conducted before the pandemic has shown that social isolation and loneliness among children and adolescents is associated with a higher risk of depression and anxiety (Loades et al. 2020).

The impact of school closures on social isolation and loneliness likely depends on other preventive measures restricting social interactions. For example, closing schools probably increases the risk of social isolation more if home quarantine is imposed than if children and adolescents are allowed to meet friends outside of school. Although social isolation affects all children it should be particularly stressful for children in dysfunctional families, where the home environment is characterized by physical or psychological abuse. Homeschooling

also puts other learning demands on the children which may be stressful, especially for those in overcrowded households with poor learning environments. The consequences of school closures and other NPIs may, however, not only be negative. Not having to travel to school frees up time for studying, the home environment can be more peaceful than the classroom at school, and as parents to a larger extent worked from home they may have had more time to help out with school work. Cancelled exams and less demands on social interactions may also alleviate the stress experienced by students. Moreover, the consequences of school closures clearly depend on the age of the child. As discussed in the previous section, remote learning is probably less effective for younger students. On the other hand, keeping primary schools shut requires parents or other caregivers to stay home with the child, which means they get more help and emotional support than older students.

In many countries, schools serve as the first point of access to mental health services. Teachers meet daily with students and can alert parents and health care services if they notice signs of mental health issues. Certain mental healthcare services are even provided at the school premises (Rones and Hoagwood, 2000). Thus, access to mental healthcare services can be affected by school closures which, in turn, can have negative long-term consequences for children's mental health.

Thus, there are reasons to believe closing schools may increase loneliness, social connectedness with peers and learning stress as well as reducing access to mental health care services provided at school. The challenge when studying the impact of school closure is that although closing schools was one of the most significant containment measures affecting the daily lives of children, it was not the only factor. Other widely implemented measures such as closing down sports and leisure activities, restricting meeting with friends and elderly relatives and stay-at-home orders, all affect the students' daily life. The pandemic and the associated measures to reduce the spread of the virus have also had effects on parental employment and family income with potential consequences for students. Moreover, students have been affected by family and friends getting severely sick with COVID-19. Since schools closed at the same time as other social distancing and lockdown measures were introduced, it is difficult to empirically disentangle the effect of school closures on mental health and well-being from effects of other factors.

There are several studies providing insight into the concerns and feelings of children and adolescents during the lockdown period. School children generally reported negative feelings about lockdown and school closures like worry about missing school, leisure activities and playing with friends. Some children do however have positive views of lockdown (Thorn and Vincent-Lancrin 2021). Whether the concerns expressed by children or their caregivers have effects on mental well-being is an open question. The section below contains a discussion of the evidence from studies using repeated cross-sectional or longitudinal data that can isolate the effects of the pandemic period from existing group differences and general trends in mental health. A special attention will be directed to studies aiming to isolate the effects of school closure.

3.1 Studies of impact of pandemic on mental health

To measure the prevalence of emotional and behavioural issues among children and adolescents, researchers commonly use screening questionnaires filled in by the caregiver or the children/adolescents themselves. One of the most widely used questionnaires is the Strengths and Difficulties Questionnaire (SDQ), which measures externalizing and internalizing problems, conduct issues as well as peer-relations and prosocial behavior. There are however a wide range of questionnaires used, complicating a comparison of effects between studies. Therefore only the direction of effects will be discussed.

The evidence from studies of the development of children's mental health during the first wave of the pandemic is mixed. Some studies find deteriorating mental health among children and adolescents. In a longitudinal study of Australian adolescents aged 13-16, Magson et al. (2020) find participants reporting increasing anxiety, sleep-related impairment and worse global health two months after school closure. Husson

et al. (2021) find worse parent-reported behavior among adolescents controlling for earlier scores and age when studying 6-16-year-olds in the US and Rogers et al. (2021) find small decreases in mental health using self-reported survey data. Similar results are found by Bignardi et al. (2020) when comparing mental health assessment of British children aged 8-11 before and after the UK lockdown, and by Luitjen et al. (2021) when comparing the incidence of anxiety, depression and difficulty sleeping among Dutch children and adolescents aged 8-18 with a similar population two years before the pandemic. The last study analyses potentially vulnerable groups and finds larger negative consequences for children living with a single parent, larger families and families where parents' labor market situation had worsened, or relatives/friends had been infected with COVID-19. The studies above have small sample sizes, ranging between 100-800 individuals. A large Icelandic study of a representative sample of adolescents showed an increase in depressive symptoms for the group assessed in October 2020 (Thorisdottier et al. 2021). Studying a more serious outcome – suicide rates in Japan – Tanaka and Okamoto (2021) find no change, compared to previous year, in the spring of 2020, but an increase in the fall of 2020 among 0-20-year-olds.

Other studies do not find deteriorating mental health among children and adolescents. Grassman-Pines et al. (2020) collect daily survey data on parent and child psychological well-being for parents of children 2-7-year-olds working in the hourly service industry in the US. The results for this potentially vulnerable group show negative effects on parents but no statistically significant effects on children's well-being. No change in mental health is found by Achterberg et al. (2021) who compare indicators of externalizing and internalizing behavior before and after lockdown among 179 Dutch 10-13-year-olds, or by two Norwegian studies of depressive symptoms among 13-16-year-olds (Hafstad et al. 2021; Burdzovic Andreas and Brunborg 2021). A longitudinal study by Munasinghe et al. (2020) of Australian 13-19-year-olds finds no effect on psychological well-being but reductions in happiness and positive emotions. Koenig et al. (2021) find a decrease in suicide plans and no change in behavioral and emotional problems in matched sample of German adolescents. Chen et al. (2021) analyze the change in self-reported stress, psychosomatic symptoms and happiness among Swedish adolescents between age 13-15, comparing a group who answered the survey right before the pandemic with a group answering the survey in April and November 2020. They find that, although mental health deteriorates between ages 13 and 15, there is no impact of the pandemic. Note that in contrast to other countries, Swedish schools for students up to age 16 never closed and other general preventive measures can be considered mild. Another type of measure of mental health is usage of health care because of poor mental health. Using population wide French register data on hospitalization for self-harm, Jollant et al. (2021) find large reductions in hospitalization for self-harm among children and adolescents in January-August 2020 compared to the same period 2019.

3.2 Studies of effect of school closures on mental health

As discussed above, it is a challenging task to isolate the impact of school closures on mental health because schools were closed jointly with the implementation of other measures to reduce virus transmission. Three studies that plausibly can identify causal effects of school closure on mental health have been identified. Takaku and Yokoyama (2021) overcome the identifying problem by exploiting that preschools remained open when schools in Japan closed on March 2, 2020. Schools closed at a time when there were no strict restrictions on daily activities, only recommendations to stay home and not to travel. Whether a child is exposed to a closing school depends on the age of the child. By comparing the outcome of the oldest children in preschool with the youngest in school (about age 7), controlling for the age gradient in mental health using information on younger and older children, it is possible to estimate a causal effect. Information on parental views on worry about child, child weight, occurrence of domestic violence and quality of marriage was collected using a survey in July and August 2020. The results show large increases in child weight and mothers worrying about the child, but no effects on outcomes related to the marriage. A crucial assumption in this study is that parental worry about the child does not increase when the child begins school also in

normal times, an assumption which is difficult to test as they lack information about parental view before the pandemic.

Another study of younger children that exploits policy differences in school closures to estimate causal effects is Blanden et al. (2021). In England all schools closed in mid-March, at the same time as stay-at-home orders were issued. School years 1-6 (ages 5-10) were however prioritized to return to school from 1 June until the end of the summer. Using information on parent reported emotional and behavioral wellbeing of children, as measured by SDQ in the UK Household Longitudinal Study collected in July, they investigate whether children in prioritized school years fared better than non-prioritized school years. The results show prioritized children, who are more likely to have been in school for about 6 weeks, scored relatively better on the SDQ compared to previous year. The survey responses from September indicate the effects diminished somewhat over time suggesting the effects become smaller over time.

The third study investigates whether the utilization of healthcare for psychiatric disorders such as depression and anxiety and prescriptions of antidepressants and ADHD drugs is affected by school closure. Svaleryd et al. (2021) exploit that only upper-secondary schools in Sweden closed in March 2020 and study healthcare utilization among upper-secondary school students (age 17-19) using lower-secondary students (age 14-16) as a control group. Using a difference-in-difference approach, they find a decrease in healthcare utilization when upper-secondary schools moved to online teaching. In particular, they find a decrease among adolescents who recently had not been in contact with mental health services and in emergency visits. A limitation with studying utilization of mental healthcare services is that it depends not only on the mental health but also on access and willingness to seek care. There was, however, no increase in utilization of mental healthcare services when upper-secondary schools fully or partly opened again in the fall of 2020 and the lower rates of mental healthcare contacts, relative to lower-secondary students, remained until the end of the study period (March 2021).

3.3 Discussion

There are by now several studies analyzing how children and adolescents responses to behavioral and emotional screening questionnaires changed during the pandemic compared to earlier assessments. The evidence reviewed shows the impact of school closures and wider lockdown measures on mental health to be inconclusive. The mixed results found between studies can not easily be attributed to country differences, ages of children and adolescents or other characteristics of study populations. Nor can they be explained by the study design or sample sizes. The analysis of hospitalization due to self-harm or suicide tend to find reduction at the beginning of the pandemic. Similar results have been found for adults in a wide range of countries (Sinyor et al. 2021).

Due to the limited number of studies trying to estimate causal effects of school closures on children's and adolescents' mental health and behavior, it is not possible to draw any firm conclusions. The studies to date show that parents report worse outcomes for children aged 5-10. In contrast, a study of healthcare contacts for psychiatric conditions show a reduction among adolescents aged 16-19 after moving to remote learning. This may be interpreted as school closure being more detrimental for children than for older students. Other possible explanations are the nature of the data used in the different studies. A weakness with parent-reported outcomes is that having children at home may change parent reporting even if the children's behavior and mood are not affected. As for register data on healthcare utilization, it is difficult to determine whether changes are due to changes in mental health or availability and willingness to seek care. Although the study compares individuals within the same health care system there may be changes in willingness to seek care that are not fully independent from school closures.

Summary

Wide-ranging school closures has been one of the most dramatic preventive measures taken to reduce virus transmission and illness due to Covid-19, and schools have closed to an unprecedented degree throughout the world. Results from the research on the efficiency of school closures to achieve its main goal are not fully consistent and different studies point in different directions. To some degree, this may reflect the methodological challenges inherent when trying to isolate the impact of one preventive measure when a host of measures are undertaken more or less concurrently. Disparate results may, however, also reflect that the impact of school closures on virus transmission is highly context-specific and - among other things - related to the overall level of community transmission as well as to other NPIs. While a number of studies indicate that closed schools helped reduce virus transmission and illness, the results indicate that this reduction is smaller when closing schools for younger children and when substantive preventive measures within schools are implemented. The methodological challenges stemming from the multifaceted and endogenous measures taken in conjunction to school closures are somewhat smaller for studies considering school reopenings. Several studies find that reopening schools can be done without this resulting in an increase in the overall rates of transmission and illness but some studies find opposing results. Again, a lower age of students, substantive preventive measures within schools, and a low general level of community transmission all seem to reduce the degree to which school reopenings contribute to virus transmission. As all studies consider the first phases of the pandemic, a potentially important caveat is that it is unclear how robust these results are to the effects of new SARS-CoV-2 variants and vaccines. Another unsurprising but important finding is that the risk of teachers being infected is substantially higher when schools are open. However, it is not clear to what extent this is due to student-teacher transmission.

Regarding the impact of school closures on student learning, the results quite clearly indicate that the expectations of lower mean achievement and a greater disparity of learning outcomes has materialized. These results are consistent across studies on standardized tests and those focusing on learning time. Whether these learning losses can be compensated for by remedial measures or if they will be exacerbated as schooling progresses, are open and important questions for future research. The findings also indicate that remote learning works better for older students than for younger but the body of research in this regard is relatively limited. It should be mentioned that some studies that use learning progress measured by various online tools tend to find opposing results. It is unclear how this corresponds to more traditional ways of measuring student learning. One possibility is that these findings at least to some extent reflect students getting increasingly accustomed to using online tools rather than learning. Clarifying the relation between actual learning and different tools of measurement is another important area for future research. An important limitation of existing research is that the impact of school closures on vocational training has hardly been studied at all. As the learning from vocational training is difficult to measure, this shortcoming is understandable but nonetheless a serious problem.

Regarding the impact of school closures on student mental health, there are few studies based on credible methods and data. The studies indicate that parents report worse outcomes for children aged 5-10. In contrast, a study of health care contacts for psychiatric conditions show a reduction among adolescents aged 16-19 after moving to remote learning. This may be interpreted as school closure being more detrimental for children than for older students. However, as the type of data used differ substantially across these studies, this interpretation should be read with caution. Moreover, the wider context, in particular restrictions affecting children outside of school, is probably important for the consequences of school closure on mental health. Thus, there are likely important interaction effects between school closures and other NPIs on the well-being and mental health of children and adolescents. A natural shortcoming with the existing literature is the short time horizon. The long-term consequences for learning and mental health may be more serious if schools are not able to compensate for the learning losses implying students permanently fall behind. The lock-down measures reduced opportunities for children and adolescents to meet and interact with others which may have hampered personal development and have negative effects on mental health in the long-run.

Whether or not to close schools involves an inevitable trade-off between conflicting societal objectives. Some degree of reduction in virus transmission has to be balanced against the learning losses and widening educational inequalities that most studies indicate. On balance, the evidence suggests that closing schools for younger students is less well-motivated than closing them for older ones. Keeping schools serving younger students open contributes less to overall virus transmission and younger students face more challenges adjusting to remote instruction. The tentative evidence on mental health further supports this conclusion. While not part of this chapter, closing schools for younger students also impose more severe repercussions on parental labor supply as alternative childcare has to be provided. If closing schools for older students is motivated and what age groups should count as “older”, are questions without definitive answers. If overall transmission is relatively low and precautionary measures are undertaken, the evidence suggests that keeping such schools open causes relatively minor problems, especially if the general level of virus transmission is modest. However, when general transmission is high, closing secondary schools may very well be a justifiable policy. In all circumstances special consideration for teachers, especially those who belong to risk-groups, are warranted as the evidence clearly suggests that infection rates among teachers increase when schools are open for in-person instruction.

References

- Achterberg M, Dobbelaar S, Boer OD, Crone EA (2021) Perceived stress as mediator for longitudinal effects of the COVID-19 lockdown on wellbeing of parents and children. *Sci Rep.* 11:2971. doi:10.1038/s41598-021-81720-8.
- Adams-Prassl A, Boneva T, Golin M, Rauh C (2020) Work That Can Be Done from Home: Evidence on Variation within and across Occupations and Industries. IZA DP #13374.
- Aiano F, Mensah A, McOwat K, Obi C, Vusirikala A, Powell A, ... Saliba V (2021) COVID-19 outbreaks following full reopening of primary and secondary schools in England: Cross-sectional national surveillance, November 2020. *The Lancet Regional Health-Europe* 6:100120. doi:10.1016/j.lanepe.2021.100120
- Agostinelli F, Doepke M, Sorrenti G, Zilibotti F (2020) When the great equalizer shuts down: Schools, peers, and parents in pandemic Times. NBER WP #28264.
- Andrew A, Cattan S, Costa Dias M, Farquharson C, Kraftman L, Krutikova S, Sevilla A (2020) Inequalities in Children's Experiences of Home Learning during the COVID-19 Lockdown in England. *Fiscal Studies* 41:653-683. doi:10.1111/1475-5890.12240
- Amodio E, Battisti M, Kourtellos A, Maggio G, Maida CM (2021) Schools opening and Covid-19 diffusion: Evidence from geolocalized microdata. *Covid Economics* 65:44–47
- Askatas N, Tatsiramos K, Verheyden B (2021) Estimating worldwide effects of non-pharmaceutical interventions on COVID-19 incidence and population mobility patterns using a multiple-event study. *Scientific reports* 11:1–13. doi:10.1038/s41598-021-81442-x
- Bacher-Hicks A, Goodman J, Mulhern C (2021) Inequality in household adaptation to schooling shocks: Covid-induced online learning engagement in real time. *Journal of Public Economics* 193:104345. doi:10.1016/j.jpubeco.2020.104345
- Blanden J, Crawford C, Fumagalli L, Rabe B (2021) School closures and children’s emotional and behavioural difficulties. Institute for Social and Economic Research, University of Essex.
- Blaskó Z, da Costa P, Schnepf SV (2021) Learning loss and educational inequalities in Europe: Mapping the potential consequences of the COVID-19 crisis. IZA DP #14298.

Bergdahl N, Nouri J, Fors U, Knutsson O (2020) Engagement, disengagement and performance when learning with technologies in upper secondary school. *Computers & Education* 149:103783. doi:10.1016/j.compedu.2019.103783

Bignardi G, Dalmaijer ES, Anwyl-Irvine AL, et al (2021) Longitudinal increases in childhood depression symptoms during the COVID-19 lockdown. *Archives of Disease in Childhood* 106:791–797. doi:10.1136/archdischild-2020-320372

Bol T (2020) Inequality in homeschooling during the Corona crisis in the Netherlands. First results from the LISS Panel. doi:10.31235/osf.io/hf32q

Bosslet MP, Jang JH, Roll R, Sperling M, Khan B (2021) The Effect of In-Person Primary and Secondary School Instruction on County-Level Severe Acute Respiratory Syndrome Coronavirus 2 Spread in Indiana. *Clinical Infectious Diseases*. doi:10.1093/cid/ciab306

Bravata D, Cantor JH, Sood N, Whaley CM (2021) Back to School: The Effect of School Visits During COVID-19 on COVID-19 Transmission. NBER WP #28645.

Burdzovic Andreas J, Brunborg GS (2021) Self-reported Mental and Physical Health Among Norwegian Adolescents Before and During the COVID-19 Pandemic. *JAMA Netw Open* 4:e2121934. doi:10.1001/jamanetworkopen.2021.21934

Canovan C, Fallon N (2021) Widening the divide: the impact of school closures on primary science learning. *SN Social Sciences* 1:1–22. doi:10.1007/s43545-021-00122-9

CDC (2021) Science Brief: Transmission of SARS-CoV-2 in K-12 Schools and Early Care and Education Programs – Updated. <https://www.ncbi.nlm.nih.gov/books/NBK570438/>

Chen Y, Osika W, Henriksson G, Dahlström J, Friberg P (2021) Impact of COVID-19 pandemic on mental health and health behaviors in Swedish adolescents. *Scandinavian Journal of Public Health* Jun 8:14034948211021724. doi:10.1177/14034948211021724

Chetty R, Friedman J, Hendren N, Stepner M (2020) How did covid-19 and stabilization policies affect spending and employment? A new real-time economic tracker based on private sector data. NBER working paper #27431

Chernozhukov, V, Kasahara, H, Schrimpf, P (2021a) Causal impact of masks, policies, behavior on early covid-19 pandemic in the US. *Journal of Econometrics* 220:23-62. doi:10.1016/j.jeconom.2020.09.003

Chernozhukov V, Kasahara H, Schrimpf P (2021b) The Association of Opening K-12 Schools and Colleges with the Spread of COVID-19 in the United States: County-Level Panel Data Analysis. *Proceedings of the National Academy of Sciences* 118:42. doi:10.1073/pnas.2103420118

Contini D, Di Tommaso ML, Muratori C, Piazzalunga D, Schiavon L (2021) The COVID-19 Pandemic and School Closure: Learning Loss in Mathematics in Primary Education. IZA DP #14785

Courtemanche, C, Garuccio, J, Le, A, Pinkston, J, Yelowitz, A (2020) Strong Social Distancing Measures In The United States Reduced The COVID-19 Growth Rate: Study evaluates the impact of social distancing measures on the growth rate of confirmed COVID-19 cases across the United States. *Health Affairs* 39:1237-1246. doi:10.1377/hlthaff.2020.00608

Courtemanche CJ, Le A, Yelowitz A, Zimmer R (2021) School Reopenings, Mobility, and COVID-19 Spread: Evidence from Texas. NBER WP #28753

Dorn E, Hancock B, Sarakatsannis J, Viruleg E. (2020) COVID-19 and learning loss—disparities grow and students need help. McKinsey & Company

ECDC (2021) COVID-19 in children and the role of school settings in transmission - second update. Technical report

Engzell P, Frey A, Verhagen MD (2021) Learning loss due to school closures during the COVID-19 pandemic. *Proceedings of the National Academy of Sciences* 118:17. doi:10.1073/pnas.2022376118

Ertem Z, Schechter-Perkins EM, Oster E, van den Berg P, Epshtein I, Chaiyakunapruk N, ... , Nelson RE (2021) The impact of school opening model on SARS-CoV-2 community incidence and mortality. *Nature Medicine* 1-7. doi:10.1038/s41591-021-01563-8

Escueta M, Quan V, Nickow A J, Oreopoulos P (2020) Education technology: An evidence-based review. *Journal of Economic Literature* 58:897–996. doi:10.1257/jel.20191507

Fuchs-Schündeln N, Krueger D, Ludwig A, Popova I (2020) The long-term distributional and welfare effects of Covid-19 school closures. NBER WP #27773

Goldhaber D, Imberman SA, Strunk KO, Hopkins B, Brown N, Harbatkin E, Kilbride T (2021) To what extent does in-person schooling contribute to the spread of COVID-19? Evidence from Michigan and Washington. NBER WP #28455

Goller D, Wolter SC (2021) “Too shocked to search”: The Covid-19 shutdowns’ impact on the search for apprenticeships. IZA DP #14345

Gore J, Fray L, Miller A, Harris J, Taggart W (2021) The impact of COVID-19 on student learning in New South Wales primary schools: an empirical study. *The Australian Educational Researcher* 1–33. doi:10.1007/s13384-021-00436-w

Grätz M, Lipps O (2021) Large loss in studying time during the closure of schools in Switzerland in 2020. *Research in Social Stratification and Mobility* 71:100554. doi:10.1016/j.rssm.2020.100554

Grewenig E, Lergetporer P, Werner K, Woessmann L, Zierow L (2021) COVID-19 and educational inequality: how school closures affect low-and high-achieving students. *European Economic Review* 103920. doi:10.1016/j.eurocorev.2021.103920

Haeck C, Lefebvre P (2020) Pandemic school closures may increase inequality in test scores. *Canadian Public Policy* 46:S82–S87. doi:10.3138/cpp.2020-055

Haelermans, C, Jacobs, M, van Vugt, L, Aarts, B, Abbink, H, Smeets, C., ... van Wetten, S (2021). A full year COVID-19 crisis with interrupted learning and two school closures: The effects on learning growth and inequality in primary education. doi:10.31219/osf.io/78fje

Hafstad G, Sætren S, Wentzel-Larsen T, Augusti E (2021) Adolescents’ symptoms of anxiety and depression before and during the Covid-19 outbreak – A prospective population-based study of teenagers in Norway. *The Lancet Regional Health-Europe* 5:100093. doi:10.1016/j.lanpe.2021.100093

Harris DN, Ziedan E, Hassig S (2021) The effects of school reopenings on COVID-19 hospitalizations. National Center for Research on Education Access and Choice.

Hussong AM, Midgette AJ, Thomas TE, et al. (2021) Coping and Mental Health in Early Adolescence during COVID-19. *Res Child Adolesc Psychopathol* 49:1113–1123. doi:10.1007/s10802-021-00821-0

Irfan O, Li, J, Tang K, Wang Z, Bhutta ZA (2021) Risk of infection and transmission of SARS-CoV-2 among children and adolescents in households, communities and educational settings: A systematic review and meta-analysis. *J Glob Health* 11:05013. doi:10.7189/jogh.11.05013

Isphording IE, Lipfert M, Pestel N (2021) Does re-opening schools contribute to the spread of SARS-CoV-2? Evidence from staggered summer breaks in Germany. *Journal of Public Economics* 198:104426. doi:10.1016/j.jpubeco.2021.104426

Jackson C, Mangtani P, Hawker J, Olowokure B, Vynnycky E (2014) The effects of school closures on influenza outbreaks and pandemics: systematic review of simulation studies. *PloS one* 9:e97297. doi:10.1371/journal.pone.0097297

- Jamison, JC, Bundy, D, Jamison, DT, Spitz, J, Verguet, S (2021) Comparing the impact on COVID-19 mortality of self-imposed behavior change and of government regulations across 13 countries. *Health Serv Res* 56:874– 884. doi:10.1111/1475-6773.13688
- Janssen LHC, Kullberg M-LJ, Verkuil B, van Zwieten N, Wever MCM, van Houtum LAEM et al. (2020) Does the COVID-19 pandemic impact parents' and adolescents' well-being? An EMA-study on daily affect and parenting. *PLoS ONE* 15:e0240962. doi:10.1371/journal.pone.0240962
- Jæger M M, Blaabæk E H (2020) Inequality in learning opportunities during Covid-19: Evidence from library takeout. *Research in Social Stratification and Mobility* 68:100524. doi:10.1016/j.rssm.2020.100524
- Jollant F, Roussot A, Corruble E, Chauvet-Gelinier J-C, Falissard B, Mikaeloff Y, Quantin C (2021) Hospitalization or self-harm during the early months of the COVID-19 pandemic in France: A nationwide retrospective observational cohort study. *The Lancet Regional Health –Europe* 6:100102. doi:10.1016/j.lanep.2021.100102
- Kaffenberger M (2021) Modelling the long-run learning impact of the Covid-19 learning shock: Actions to (more than) mitigate loss. *International Journal of Educational Development* 81:102326. doi:10.1016/j.ijedudev.2020.102326
- Koenig J, Kohls E, Moessner M et al (2021) The impact of COVID-19 related lockdown measures on self-reported psychopathology and health-related quality of life in German adolescents. *European Child & Adolescent Psychiatry* 1-10. doi:10.1007/s00787-021-01843-1
- Kogan V, Lavertu S (2021) How the COVID-19 Pandemic Affected Student Learning in Ohio. Analysis of Spring 2021 Ohio State Tests. Ohio State University, Report for the Ohio Department of Education
- Lessler J, Grabowski M K, Grantz KH, Badillo-Goicoechea E, Metcalf CJE, Lupton-Smith C, ... Stuart EA (2021) Household COVID-19 risk and in-person schooling. *Science* 372:1092–1097. doi:10.1126/science.abh2939
- Lewis K, Kuhfeld M, Ruzek E, McEaching A (2020) Learning during COVID-19: Reading and math achievement in the 2020-21 school year. NWEA.
- Liu Y, Morgenstern C, Kelly J, Lowe R, Jit M (2021a) The impact of non-pharmaceutical interventions on SARS-CoV-2 transmission across 130 countries and territories. *BMC medicine* 19:1–12. doi:10.1186/s12916-020-01872-8
- Liu X, Xu X, Li G, Xu X, Sun Y, Wang F, ... Zhang L (2021b) Differential impact of non-pharmaceutical public health interventions on COVID-19 epidemics in the United States. *BMC public health* 21:1–7. doi:10.1186/s12889-021-10950-2
- Luijten MAJ, van Muilekom MM, Teela L et al. (2021) The impact of lockdown during the COVID-19 pandemic on mental and social health of children and adolescents. *Qual Life Res* 30:2795–2804. doi:10.1007/s11136-021-02861-x
- Magson NR, Freeman JYA, Rapee RM, Richardson CE, Oar EL, Fardouly J (2021) Risk and Protective Factors for Prospective Changes in Adolescent Mental Health during the COVID-19 Pandemic. *J Youth Adolesc* 50:44–57. doi:10.1007/s10964-020-01332-9
- Maldonado JE, De Witte K (2021) The effect of school closures on standardised student test outcomes. *Br Educ Res J*. doi:10.1002/berj.3754
- Major LE, Eyles A, Machin S (2021) Learning loss since lockdown: variation across the home nations. *CEP Covid Analysis #23*
- Meeter M (2021) Primary school mathematics during Covid-19: No evidence of learning gaps in adaptive practicing results. *PsyArXiv*. doi:10.31234/osf.io/8un6x

- Munasinghe S, Sperandei S, Freebairn L, Conroy E, Jani H, Marjanovic S, Page A (2020) The impact of physical distancing policies during the covid-19 pandemic on health and wellbeing among Australian adolescents. *J Adol Health* 67:653–661. doi:10.1016/j.jadohealth.2020.08.008
- OECD (2021) *The State of Global Education: 18 Months into the Pandemic*. OECD Publishing, Paris. doi:10.1787/1a23bb23-en.
- Pier L, Christian M, Tymeson H, Meyer R H (2021) COVID-19 impacts on student learning: Evidence from interim assessments in California. *Policy Analysis for California Education*
- Piovani, D, Christodoulou, MN, Hadjidemetriou, A, Pantavou, K, Zaza, P, Bagos, PG, ... Nikolopoulos, GK (2021) Effect of early application of social distancing interventions on COVID-19 mortality over the first pandemic wave: An analysis of longitudinal data from 37 countries. *Journal of Infection* 82:133-142. doi:10.1016/j.jinf.2020.11.033
- Reinbold GW (2021) Effect of fall 2020 K-12 instruction types on CoViD-19 cases, hospital admissions, and deaths in Illinois counties. *American journal of infection control* 49:1146–1151. doi:10.1016/j.ajic.2021.05.011
- Reimer D, Smith E, Andersen IG, Sortkær B (2021) What happens when schools shut down? Investigating inequality in students' reading behavior during Covid-19 in Denmark. *Research in Social Stratification and Mobility* 71:100568. doi:10.1016/j.rssm.2020.100568
- Rogers AA, Ha T, Ockey S (2021) Adolescents' Perceived Socio-Emotional Impact of COVID-19 and Implications for Mental Health: Results From a U.S.-Based Mixed-Methods Study. *J Adolesc Health* 68:43–52. doi:10.1016/j.jadohealth.2020.09.039
- Rones M, Hoagwood K (2000) School-Based Mental Health Services: A Research Review. *Clin Child Fam Psychol Rev* 3:223–241. doi:10.1023/A:1026425104386
- Rose S, Twist L, Lord P, Rutt S, Badr K, Hope C, Styles B (2021) Impact of school closures and subsequent support strategies on attainment and socio-emotional wellbeing in Key Stage 1: Interim Paper 2. Education Endowment Foundation
- Schult J, Mahler N, Fauth B, Lindner M A (2021) Did students learn less during the COVID-19 pandemic? Reading and mathematics competencies before and after the first pandemic wave. *PsyArXiv*. doi:10.31234/osf.io/pqtgf
- Sinyor M, Knipe D, Borges G, Ueda M, Pirkis J, Phillips M, Gunnell D & the International COVID-19 Suicide Prevention Research Collaboration (2021) Suicide Risk and Prevention During the COVID-19 Pandemic: One Year On, *Archives of Suicide Research*, doi:10.1080/13811118.2021.1955784
- Skar GBU, Graham S, Huebner A (2021) Learning loss during the COVID-19 pandemic and the impact of emergency remote instruction on first grade students' writing: A natural experiment. *Journal of Educational Psychology*. doi:10.1037/edu0000701
- Spitzer MWH, Musslick S (2021) Academic performance of K-12 students in an online-learning environment for mathematics increased during the shutdown of schools in wake of the COVID-19 pandemic. *PloS one* 16:e0255629. doi:10.1371/journal.pone.0255629
- Svaleryd H, Björkegren E, Vlachos J (2021) The impact of the COVID-19 school closure on adolescents' use of mental healthcare services in Sweden. *MedRxiv*. doi:10.1101/2021.12.12.21267684.
- Takaku R, Yokoyama I (2021) What the COVID-19 school closure left in its wake: Evidence from a regression discontinuity analysis in Japan. *Journal of Public Economics* 195:104364. doi:10.1016/j.jpubeco.2020.104364
- Tanaka T, Okamoto S (2021) Increase in suicide following an initial decline during the COVID-19 pandemic in Japan. *Nature Human behaviour* 5:229–238. doi:10.1038/s41562-020-01042-z

- Thorisdottir I, Asgeirsdottir B, Kristjansson A, Valdimarsdottir H, Jonsdottir Tolgyes E, Sigfusson J, Allegrante J, Sigfusdottir I, Halldorsdottir T (2021) Depressive symptoms, mental wellbeing, and substance use among adolescents before and during the COVID-19 pandemic in Iceland: a longitudinal, population-based study. *The Lancet Psychiatry* 8:663–672. doi:10.1016/S2215-0366(21)00156-5
- Thorn W, Vincent-Lancrin S (2021) *Schooling During a Pandemic: The Experience and Outcomes of Schoolchildren During the First Round of COVID-19 Lockdowns*. OECD Publishing, Paris. doi:10.1787/1c78681e-en.
- Tomasik MJ, Helbling L A, Moser U (2021). Educational gains of in-person vs. distance learning in primary and secondary schools: A natural experiment during the COVID-19 pandemic school closures in Switzerland. *International Journal of Psychology* 56:566–576. doi:10.1002/ijop.12728
- UNESCO (2021). *Education: From disruption to recovery*. <https://en.unesco.org/covid19/educationresponse> [retrieved Nov 28, 2021]
- van der Velde M, Sense F, Spijkers R, Meeter M, van Rijn H (2021) Lockdown learning: Changes in online foreign-language study activity and performance of Dutch secondary school students during the COVID-19 Pandemic. *Frontiers in Education* 6:294. doi:10.3389/feduc.2021.712987
- Vlachos J, Hertegård E, Svaleryd H (2021). The effects of school closures on SARS-CoV-2 among parents and teachers. *Proceedings of the National Academy of Sciences* 118:9. doi:10.1073/pnas.2020834118
- von Bismarck-Osten C, Borusyak K, Schönberg U (2021) The role of schools in transmission of the SARS-CoV-2 virus: Quasi-experimental evidence from Germany. Forthcoming in *Economic Policy*.
- Walsh S, Chowdhury A, Braithwaite V, ..., Mytton, O. (2021) Do school closures and school reopenings affect community transmission of COVID-19? A systematic review of observational studies. *BMJ Open* 2021:11:e053371. doi:10.1136/bmjopen-2021-053371
- Werner K, Woessmann L (2021) *The Legacy of Covid-19 in Education*. CESifo Working Paper 9358
- West MR, Lake R (2021) *How Much Have Students Missed Academically Because of the Pandemic? A Review of the Evidence to Date*. Center on Reinventing Public Education
- Wyse AE, Stickney EM, Butz D, Beckler A, Close CN (2020) The potential impact of COVID-19 on student learning and how schools can respond. *Educational Measurement: Issues and Practice* 39:60–64. doi:10.1111/emip.12357