ISSN 1831-9424

European Commission

JRC TECHNICAL REPORT

The impact of Covid-19 physical school closure on student performance in OECD countries: a meta-analysis

Di Pietro, G.

2023

Joint Research Centre

EUR 31656 EN

Contact information
Name: Giorgio Di Pietro
Address: Edificio Expo, c. Inca Garcilaso, 3, 41092 Seville (Spain)
Email: giorgio.di-pietro@ec.europa.eu
Tel.: (+34) 954488479

EU Science Hub
https://joint-research-centre.ec.europa.eu

JRC134506

EUR 31656 EN

PDF ISBN 978-92-68-07469-5 ISSN 1831-9424 doi:10.2760/197242 KJ-NA-31-656-EN-N

Luxembourg: Publications Office of the European Union, 2023

How to cite this report: Di Pietro, G. *The impact of Covid-19 physical school closure on student performance in OECD countries: a meta-analysis*, Publications Office of the European Union, Luxembourg, 2023, doi:10.2760/197242, JR134506

Contents

Abstract

In this report, we conduct a new meta-analysis of papers examining the impact of Covid-19 school related closure on student performance. While we focus only on OECD countries, the present meta-analysis includes, to the best of our knowledge, a larger number of studies (i.e., 55), effect sizes (i.e., 400) and countries (i.e., 21) than previous similar studies. Our results confirm that Covid-19 had, on average, an adverse effect on learning. While the size of the overall learning loss is estimated to be between 0.11 and 0.17 standard deviations of student achievement, learning losses are found to be smaller for pupils in OECD EU countries than for their peers in OECD non-EU countries. The periods of physical school closure were shorter in OECD EU countries than in OECD non-EU countries and this may provide a possible explanation for our finding. Additionally, our study shows that, overall, students seem to have fallen behind in their learning more in the later stages of the pandemic compared with the earlier stages. This finding is at variance with the outcome of earlier meta-analyses concluding that students did not lose any additional ground but failed to rebound. Our result is driven by the inclusion of recent studies showing that pandemic-related learning deficits have accelerated over time. Consequently, our findings suggest that particular attention should continue to be paid towards ensuring that students are able to catch up on what they have missed while schools have been closed.

Acknowledgements

I would like to thank Marco Montanari from DG EAC and an anonymous reviewer for their helpful and constructive comments on earlier versions of this report. The usual disclaimer applies.

Opinions expressed herein are mine only and do not reflect the views of, or involve any responsibility for, the institutions to which I am affiliated.

Authors

Giorgio Di Pietro, European Commission, Joint Research Centre, Seville

1 Introduction

Following the spread of Covid-19 in spring 2020, almost all educational institutions around the world were temporarily closed (UNESCO, 2020). Given the impossibility to conduct face to face education, students had to continue their learning online from home. However, the switch to remote education was sudden and many teachers and students were unprepared for this change. There is evidence showing that a lot of teachers did not possess the pedagogical and digitals skills required for online teaching (Newton, 2020). Similarly, a large number of students did not have the appropriate technological resources (e.g., laptop/tablet, stable internet connection) to follow virtual classes at home (Di Pietro et al., 2020; Blaskó et al., 2022). Additionally, some students had to share their computer with other family members and did not have a quiet space to study at home (Bolt, 2021). One should also consider that due to the pandemic children were confined to a long period of social isolation, which could have affected their well-being (European Commission/EACEA, 2022; Baarck et al., 2021). The increased risks of depression and anxiety are likely to have adversely impacted student performance given the close association between mental health and achievement (Wang et al., 2023).

Consistent with the above arguments, there is a large consensus, supported by empirical evidence, that Covid-19 school closure caused a learning loss among students. This is to say that students, on average, learned less during the pandemic relative to what they would have learned if the pandemic had not occurred. However, most of the existing evidence comes from single-country studies given the lack of relevant harmonised cross-country data, at least until recently (PIRLS 2021 microdata were realised in June 2023[1]). A strategy that can be employed to overcome this problem and hence deliver results of more general relevance is meta-analysis. Meta-analysis techniques combine and summarise the findings of individual national studies, thus producing outcomes with increased statistical power and less biases (Borenstein et al., 2021).

While there are already several systematic reviews (Patrinos et al., 2022; Moscoviz and Evans, 2022, Donnelly and Patrinos, 2021; Hammerstein et al., 2021; Zierer, 2021) and meta-analyses (Storey and Zhang, 2022; König and Frey, 2022; Di Pietro, 2023; Betthäuser et al., 2023) looking at the impact of the pandemic on student achievement, more research of this type is still needed. First, the literature in this area is expanding very quickly and evidence about the Covid-19 educational impact in certain countries has only been recently published for the first time. Second, given that most new studies consider results of assessments that took place one year or more after the first lockdown, updated meta-analyses allow us to investigate how learning losses have changed since the early stages of the pandemic. It is very important to understand if and to what extent students have been able to catch up with unfinished learning from the pandemic. Without effective remedial education, there could be long-term negative consequences for students and society. Students would enter the labour market with lower skills levels, and this would translate into lower employment opportunities and lower wages (Psacharopoulos et al., 2020). At macro-level, such a situation would have an adverse effect on economic growth (Hanushek and Woessmann, 2020).

We focus on OECD countries. The advantage of doing so is that these tend to be high income and upper-middle income countries with similar economic characteristics (Yilanci et al., 2019). On the other hand, however, our analysis does not capture the challenges faced by less developed countries whose students are especially likely to have suffered from a lack of devices, resources and internet connectivity, which might have prevented them from pursuing learning online. Despite considering only OECD countries, our meta-analysis does expand on previous meta-analyses and systematic reviews by using a larger number of effect sizes and studies[2]. Specifically, a total of 400 separate estimates from 55 studies are considered. Additionally, this meta-analysis covers a larger number of countries (i.e., 21) than previous meta-analyses[3].

The remainder of this study is organised as follows. Section 2 describes the process of selecting studies and collecting data. It also discusses the empirical approach and the possibility of publication bias. Section 3 reports and discusses the main empirical results. Section 4 presents additional findings when analysing the educational

[1] Kennedy and Strietholt (2023) use PIRLS 2021 data to examine the impact of the pandemic on student achievement.

[2] Previous meta-analyses include König and Frey (2022) who extracted 109 effect sizes nested in 18 studies, Storey and Zhang (2021) who synthetized 79 effect sizes from 10 studies, Betthäuser et al. (2023) who considered 291 effect sizes from 42 studies, and Di Pietro (2023) who considered 239 effect sizes from 39 studies. The reviews by Patrinos et al. (2022), Moscoviz and Evans (2022), Donnelly and Patrinos (2021), Hammerstein et al. (2021) and Zierer (2021) summarised the results of 35 studies, 29 studies, 8 studies, 11 studies and 9 studies, respectively.

[3] Both König and Frey (2022) and Storey and Zhang (2021) considered 5 countries. While the meta-analysis by Betthäuser et al. (2023) covered 15 countries, Di Pietro (2023) collected relevant information from studies conducted in 19 different countries.

impact of Covid-19 broken down by gender and socio-economic status. Section 5 looks at remedial policies designed to alleviate the learning losses due to the pandemic. Section 6 concludes.

2 Method

To carry out this meta-analysis, we followed the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) (Moher et al., 2009).

2.1 Inclusion criteria

With the purpose of this study in mind, a set of inclusion criteria was defined. They guided the selection of the studies included in this meta-analysis. Specifically, the following four inclusion criteria were used:

● the study should quantitatively examine the effect of Covid-19 on student achievement in primary, secondary or tertiary education in an OECD country. This means that the data used in this study were collected before and during the pandemic (or only during the pandemic if, when schools were closed, some students were still receiving in-person teaching thereby simulating pre-pandemic conditions), therefore clearly distinguishing between a control and a treated group, respectively.

● the study should use objective indicators (e.g., test scores) to measure student achievement.

● the study should be based on real data.

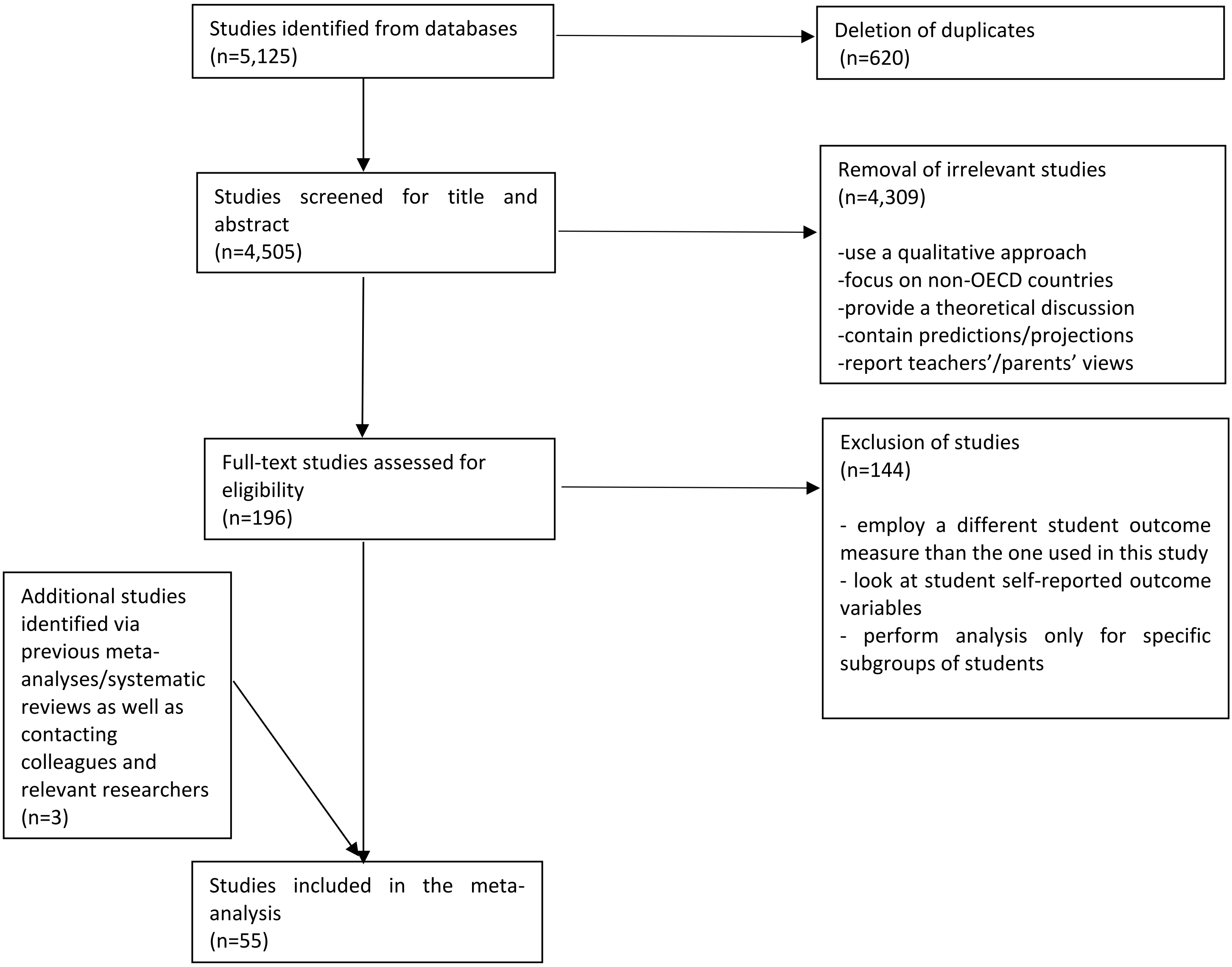
● the study should report data on an effect size (or sufficient information to compute it) and its standard error (or *t*-statistic, *p*-value, or sufficient information to calculate it).

2.2 Search and screening procedures

In order to ensure a comprehensive and multidisciplinary search, we consulted five electronic databases (i.e., Google Scholar, EconLit, ScienceDirect, Education Resources Information Center, and PubMed). We employed the following keywords: "Covid-19 (OR coronavirus OR pandemic OR Cov) AND student (OR academic OR scholastic) performance (OR achievement OR learning OR outcome) OR test score".

This search, which ended on 6th March 2023, yielded thousands of results. After removing duplicates, we screened the title and abstract of each remaining item. The large majority of these studies were excluded because they use qualitative approaches (e.g., interviews), report teachers'/parents' views about the educational impact of Covid-19 (e.g., Kim et al., 2023; Lupas et al., 2021), focus on non-OECD countries (e.g., El Said, 2021; Fen et al., 2021), or provide a theoretical discussion about how the pandemic is likely to affect education (e.g., Di Pietro et al., 2020). Similarly, studies containing predictions and/or projections were also removed (Kuhfeld et al., 2020a). After this initial screening, the content of the remaining 196 studies was carefully examined, and only those fulfilling all the inclusion criteria were considered. In this phase, we excluded studies that, although attempting to understand how the pandemic impacted student learning, employ a different outcome measure (e.g., dropout rate) than the one considered in this meta-analysis (e.g., Tsolou et al., 2021). In the same vein, we removed studies using student self-reported outcome measures as well as those examining the educational impact of Covid-19 on specific subgroups of students (e.g., Agostinelli et al., 2022). Additionally, in order to ensure that key sources were not missed, we consulted reference lists included in previous meta-analyses/systematic reviews and contacted colleagues and researchers who have an interest in this area. 3 more relevant studies were identified in this way. A total of 55 studies was included in this study. Figure 1 summarizes the literature search and the screening procedure.

Figure 1: Flowchart illustrating the review selection process



2.3 Study coding

All the studies included in this meta-analysis were read in-depth, and relevant information and findings were extracted.

In line with the current best practice in meta-analysis (Polák, 2019), we use all relevant estimates included in the selected studies. As argued by Cheung (2019), not doing so results in missed opportunities to take advantage of all the available data to answer the research question/s under investigation. However, a fundamental issue with this approach lies in the dependence between multiple estimates from the same study given that effect sizes are assumed to be independent in meta-analysis (Cheung and Vijayakumar, 2016). As discussed later in the report (see Section 2.4), the Robust Variance Estimation (RVE) approach is used to account for within-study dependence.

2.3.1 Effect size calculation

In order to be able to aggregate the various impact estimates reported in the selected studies, one needs to convert them into a common metric. Consistent with previous relevant systematic reviews and meta-analyses, the Cohen's *d* as a scale-free effect size measure is used. Cohen's *d* refers to standardised mean differences and is calculated by dividing the mean difference in student performance between pre-Covid and Covid periods by the pooled standard deviation. While in some cases the Cohen's *d* was retrieved from the studies, in others it was calculated using information directly available from them. If not reported, the Cohen's *d* standard error was computed using the formula given in Cooper and Hedges (1994). In case no information on sample sizes were available from the studies but exact *p*-values were instead reported, the formula provided by Higgins and Green (2011) was employed to obtain standard errors. In some instances, we also used information on effect sizes contained in the electronic supplements of the meta-analysis articles by König and Frey (2022), Di Pietro (2023), and Betthäuser et al. (2023). For instance, this was the case when a study does not report Cohen's *d* but this information has been already collected by König and Frey who have contacted the relevant author/s.

2.3.2 Moderator variables

Six variables were coded as possible moderators:

a) Subject area

Following the approach of Di Pietro (2023), three different subject areas are selected: humanities, math/science and a mixed category. Several studies (e.g., Imberman and Strunk, 2023) suggest that the pandemic had a detrimental effect especially on math achievement. During the lockdown, parents might have found more difficult to support their children with math learning compared to language and literacy.

b) Geographical area

We distinguish between EU OECD countries (Italy, Germany, Netherlands, Finland, Sweden, Spain, Belgium, Hungary, Denmark, Poland, Greece, Czech Republic and Slovenia) and non-EU OECD countries (UK, US, Mexico, Turkey, Australia, Colombia, Norway and Switzerland).

c) Level of education

We differentiate between three levels of education: primary, secondary and tertiary. It is plausible that the level of education may serve as moderator as the pandemic could have had a detrimental impact especially on the achievement of children of younger age given that remote learning is particularly challenging for this group of students (Hinton, 2020).

d) Timing of student assessment during Covid-19

In order to investigate if and to what extent students recovered from the learning loss caused by virtual learning, it is important to look at how the impact of Covid-19 on student achievement varied across the different stages of the pandemic. Specifically, we distinguish between assessments that have taken place in the early stages of Covid-19 (i.e., 2020) and those that occurred in later stages (i.e., 2021 or after).

e) Type of publication

We distinguish between peer reviewed journal articles and other studies. Publication type is a common moderator variable in meta-analysis. Peer reviewed journal articles are expected to be of higher scientific rigour and are less likely to contain typos or errors in the reported results.

f) Publication year

Publication year is another typical moderator variable in meta-analysis. In line with the approach followed by several meta-analyses (e.g., Di Pietro, 2022; Havranek and Irsova, 2017), the year of the first appearance of a draft of the study in Google Scholar is used. This measure is preferred to the nominal publication year because of increasing publication lags (Zigraiova et al., 2020).

2.4 Estimators and models

Two approaches frequently used in the meta-analysis literature are: 1) the Fixed Effects (FE) model, and 2) the Random Effects (RE) model. They rely on different assumptions. The FE model assumes that there is one true effect size common to all studies and that all differences in the observed effects can be attributed to within-study sampling error. By contrast, the RE model states that the effect size may vary between studies not only due to within-study sampling error, but also because there is heterogeneity in true effects between studies. Such additional variability is typically modelled employing a between-study variance parameter. Considering the differing characteristics of the studies included in our sample, it seems unreasonable to assume that there is a common true effect that every study shares. Hence, it is anticipated that the RE model would be more suitable.

In our empirical analysis, we use the RE model to: a) compute estimates of the overall effect size, and b) run moderator analyses to explore potential sources of heterogeneity of results.

Following the suggestion of Veroniki et al. (2019), we first compute pooled effect sizes using several estimators (i.e., Restricted Maximum Likelihood (RML), DerSimonian and Laird (DL), Paule-Mandel (PM), and Sidik-Jonkman (SJ) that adopt different methods to estimate the between-study variance component. Furthermore, we apply the so-called Knapp-Hartung adjustment (Knapp and Hartung, 2003) to obtain more reliable estimates of the standard errors (and thus the confidence intervals) of the pooled effect sizes. The advantages related to the Knapp-Hartung method are outlined in several studies (see, for instance, Langan et al., 2019).

Additionally, to test the robustness of the above results, in line with the approach of several papers (e.g., Kaiser and Menkhoff, 2020), an overall effect size is also computed using the RVE method, which accounts for the possibility that multiple effect sizes from the same study are non-independent. The benefits of this method are that there is no need to drop any effect size (to ensure their statistical independency) and no information is required about the intercorrelation between effect sizes within studies.

Next, in an attempt to identify factors that may explain why the extent of the Covid-19 learning loss is found to vary across the included studies, moderator analyses are performed. Specifically, in order to test for the significance of categorial moderator variables, we compute Q-between (Q_B), an index of the variability between the group means. Q_B has a χ^2 distribution with L-1 degrees of freedom (where L is the number of groups) and its null hypothesis is the homogeneity of the groups. Q_B statistics assess the amount of variance that can be attributed to between-group differences (Sirin and Sin, 2023). A significant Q_B would suggest that the mean effect sizes across categories differ by more than sampling error. Analyses for moderators (i.e., level of education, subject area, publication year, publication type, timing of student assessment during Covid-19 and geographical area) are basically analogous to subgroup analyses of variance.

2.5 Sample characteristics

The dataset employed for the meta-analysis comprises a total of 400 different impact estimates extracted from 55 separate studies. Each study contained in the dataset includes a number of estimates that vary from 1 to 32. Several reasons explain why most studies (i.e., 87.3%) reported multiple estimates. Many studies (e.g., Maldonado and De Witte, 2022; Gambi and De Witte, 2021; Borgonovi and Ferrara, 2022; Bielinski et al., 2021; Vegas, 2022) estimated the effect of Covid-19 on student performance in several subjects. Similarly, a large number of studies (e.g., Contini et al., 2021; Gore et al., 2021; Domingue et al., 2021) examined the impact of the pandemic on the achievement of students of different levels of education or even of students of different grades within the same level of education. For instance, Meeter (2021) analysed how Covid-19 affected the math performance of primary school children of grades 2-6. Some studies also provided different estimates showing both the short and long-term effects of Covid-19 on student achievement. For example, Kuhfeld et al. (2022) looked at changes in student test scores in autumn 2020 and autumn 2021 relative to autumn 2019.

Table 1 presents the studies included in the dataset. Studies are listed alphabetically. For each study, we report information on the author(s), year of publication[4], country examined, number of the effect sizes collected and

[4] In this table, we report the actual year of publication of the latest version of the study (for journal articles this is the year when they are assigned a volume and issue number) rather than the year of the first appearance of a draft of the study in Google Scholar.

their mean value. The studies cover a total of 21 countries. The largest source countries are the US (129 estimates), the UK (58 estimates), Belgium (48 estimates) and Germany (41 estimates).

Table 1: Sources for meta-analysis

Study (Author(s) and year of publication)	Country	Number of effect sizes collected	Mean effect size
Arenas and Gortazar (2022)	Spain	4	-0.04
Bazoli et al. (2022)	Italy	6	-0.16
Bielinski et al. (2021)	US	16	-0.13
Birkelund and Karlson (2021)	Denmark	5	0.05
Blainey and Hannay (2021a)	UK	12	-0.06
Blainey and Hannay (2021b)	UK	12	-0.19
Blainey and Hannay (2021c)	UK	12	-0.12
Borgonovi and Ferrara (2022)	Italy	4	-0.04
Contini et al. (2021)	Italy	2	-0.21
Coskun and Kara (2022)	Turkey	1	-0.34
De Paola et al. (2022)	Italy	1	-0.11
Department for Education (2021a)	UK	6	-0.11
Department for Education (2021b)	UK	2	-0.17
Depping et al. (2021)	Germany	32	-0.01
Domingue et al. (2021)	US	4	-0.03
Engzell et al. (2021)	Netherlands	4	-0.08
Fälth et al. (2021)	Sweden	18	0.09
Förster et al. (2023)	Germany	2	0.06
Gambi and De Witte (2021)	Belgium	22	-0.13
Gambi and De Witte (2023)	Belgium	15	-0.21
Gillitzer and Prasad (2022)	Australia	9	-0.02
GL Assessment (2021)	UK	4	-0.22
Gore et al. (2021)	Australia	4	0.04
Haelermans et al. (2021)	Netherlands	3	-0.12
Hevia et al. (2022)	Mexico	2	-0.54
Jakubowski et al. (2022)	Poland	2	-0.30
Kofoed et al. (2021)	US	5	-0.22
Kogan and Lavertu (2021a)	US	1	-0.23
Kogan and Lavertu (2021b)	US	11	-0.23
Korbel and Prokop (2021)	Czech Republic	2	-0.08
Kozakowski et al. (2021)	US	12	-0.13
Kuhfeld et al. (2020b)	US	12	-0.10
Kuhfeld et al. (2022)	US	24	-0.12
Lambropoulos et al. (2022)	Greece	2	-0.26
Lerkkanen et al. (2023)	Finland	11	-0.12
Locke et al. (2021)	US	14	-0.14
Ludewig et al. (2022)	Germany	2	-0.17
Maldonado and De Witte (2022)	Belgium	11	-0.16
Meeter (2021)	Netherlands	10	0.15
Molnár and Hermann (2023)	Hungary	18	-0.11
Moliner and Alegre (2022)	Spain	1	-2.34
Moliner et al. (2022)	Spain	1	-0.95
Orlov et al. (2021)	US	2	-0.12
Pier et al. (2021)	US	25	-0.14
Relyea et al. (2022)	US	3	-0.36
Rose et al. (2021)	UK	6	-0.17
Schult et al. (2021)	Germany	3	-0.06
Schuurman et al. (2023)	Netherlands	2	-0.08

Skar et al. (2021)	Norway	2	-0.48
Spitzer and Musslick (2021)	Germany	2	0.15
Tomasik et al. (2021)	Switzerland	2	-0.07
van Der Velde (2021)	Netherlands	1	0.25
Vegas (2022)	Colombia	6	-0.27
Weidmann et al. (2021)	UK	4	-0.01
Žnidaršič et al. (2022)	Slovenia	1	0.11

Table 2 provides descriptive statistics for our moderator variables. While Column 1 reports simple averages (and standard deviations), Column 2 shows averages (and standard deviations) weighted by the inverse of the number of estimates reported in each study.

Table 2: Descriptive statistics

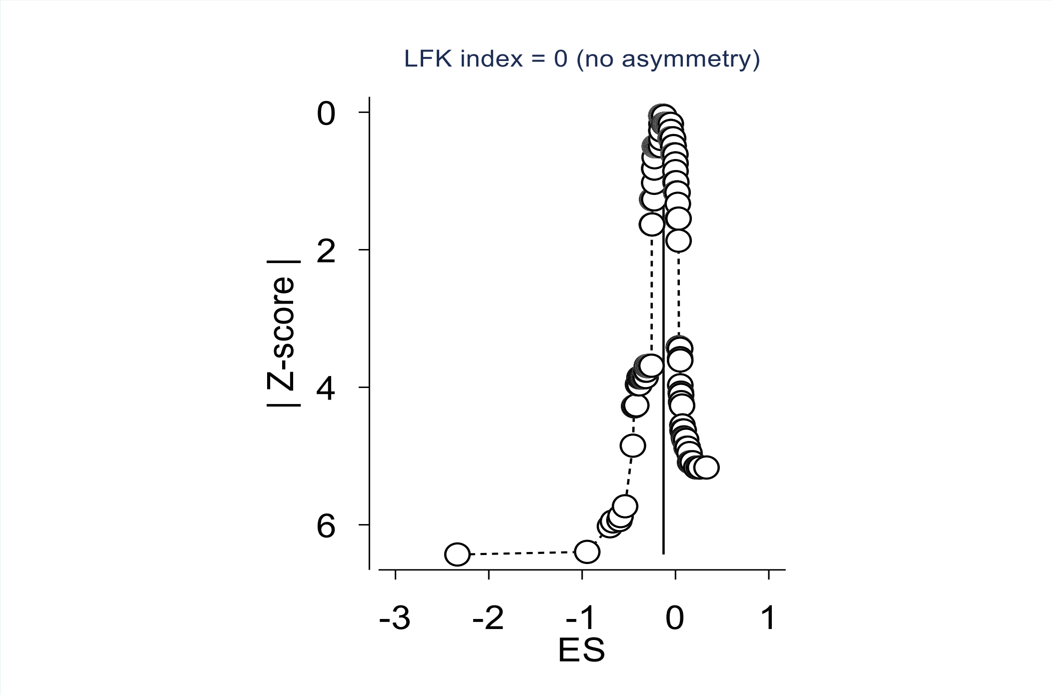
Variable name	Unweighted Mean (Standard deviation) (1)	Weighted (by the inverse of the number of estimates reported in each study) Mean (Standard deviation) (2)
Effect size (Cohen's *d*)	-0.113 (-0.010)	-0.174 (0.018)
Year of publication		
2020	0.093 (0.015)	0.073 (0.013)
2021	0.606 (0.024)	0.545 (0.025)
2022	0.178 (0.019)	0.291 (0.023)
2023	0.123 (0.106)	0.091 (0.014)
Subject area		
Math/Science	0.444 (0.025)	0.421 (0.025)
Humanities	0.528 (0.025)	0.506 (0.025)
Mix	0.028 (0.008)	0.073 (0.013)
Level of education		
Primary	0.670 (0.024)	0.605 (0.024)
Secondary	0.308 (0.023)	0.322 (0.023)
Tertiary	0.022 (0.007)	0.073 (0.013)
Timing of student assessment during Covid-19		
2020	0.488 (0.025)	0.530 (0.025)
2021 or later	0.512 (0.025)	0.470 (0.025)
Geographical area		
OECD EU Member States	0.423 (0.025)	0.491 (0.025)
OECD non-EU Member States	0.577 (0.025)	0.509 (0.025)
Type of publication		
Peer reviewed journal articles	0.203 (0.020)	0.345 (0.024)
Other studies	0.797 (0.020)	0.655 (0.024)

2.6 Publication bias

Publication bias is a serious issue in meta-analysis, which can undermine the validity and generalization of the conclusions (Lin and Chu, 2018). It occurs because there is a tendency for researchers to submit or scientific journals to publish articles producing statistically significant results as opposed to null or uncertain results (Ji et al., 2011).

We use the Doi plot to visually assess publication bias. It employs a folded normal quantile (Z-score) versus effect plot. The main advantages of the Doi plot are that it aids visualization of asymmetry (in the absence of publication bias there is no asymmetry), and it quantifies the asymmetry through the Luis-Furuya-Kanamori (LFK) index. LFK index values within ±1 suggest no asymmetry, LFK index values exceeding ±1 but within ±2 indicate minor asymmetry, while LFK index values exceeding ±2 denote major asymmetry (Furuya-Kanamori et al., 2018). As shown in Figure 2, the Doi plot shows no asymmetry (LFK index=0), indicating that no publication bias is detected. Our findings are consistent with those in previous relevant meta-analyses. König and Frey (2022), Di Pietro (2023), and Betthäuser et al. (2023) conclude that the presence of publication bias is unlikely.

Figure 2: Doi plot



3 Main results

We present results in two steps. First, we analyse overall effect sizes (Section 3.1). Second, we run moderator analyses to investigate sources of heterogeneity in effect sizes (Section 3.2).

3.1 Overall effect sizes

Table 3 shows summary statistics of the overall effect sizes employing the RE model. Column 1 of Table 3 reports the results using the RML estimator. The point estimate of the overall effect size turns out to be -0.108 (SE=0.009, *p*-value=0.000, 95% CI [-0.125, -0.091]). As shown in Columns 2, 3, and 4 of Table 3, results do not significantly change when other RE estimators are employed. More precisely, the point estimate of the overall effect size ranges between -0.105 (using DL) and -0.109 (using both PM and SJ), and it is always highly statistically significant. Similarly, regardless of the RE estimator used, the relevant point estimate continues to be highly statistically significant even when the Hartung-Knapp method is employed to compute the standard error of the pooled effect size. Additionally, both Cochran's Q test and the I^2 statistic indicate considerable heterogeneity across the results of the selected studies, thus confirming the appropriateness of the RE model. I^2, which is an index typically used to quantify the degree of heterogeneity in a meta-analysis (Higgins and Thompson, 2002), has consistently a value of 100% across the RE estimators. This suggests that all the variability in the effect-size estimates is due to heterogeneity as opposed to sampling error.

Table 3: Summary statistics of the overall effect sizes- Random Effects model

	Restricted Maximum Likelihood (RML) (1)	Sidik-Jonkman (SJ) (2)	DerSimonian and Laird (DL) (3)	Paule-Mandel (PM) (4)
Effect size (Standard Error) [p-value]	-0.108 (0.009) [0.000]	-0.109 (0.009) [0.000]	-0.105 (0.006) [0.000]	-0.109 (0.009) [0.000]
95% Confidence Interval 95% Hartung–Knapp Confidence Interval	-0.125, -0.091 -0.126, -0.090	-0.127, -0.091 -0.127, -0.091	-0.116, -0.095 -0.122, -0.088	-0.127, -0.091 -0.127, -0.091
Q-statistic [p-value]	4300000000 [0.000]	4300000000 [0.000]	4300000000 [0.000]	4300000000 [0.000]
I^2(%)	100	100	100	100

Next, in order to address within-study dependence in effect sizes, the RVE approach is employed. We fit an intercept-only RE RVE model to our set of effect sizes to compute the overall summary effect. In this model, the intercept can be interpreted as the precision-weighted mean effect size adjusted for effect-size dependence (Friese et al., 2017). The RVE RE mean effect size turns out to be -0.1735[5] (SE=0.055, *p*-value=0.0005, 95% CI [-0.2676, -0.0795]), which is larger than our previous estimates. It is also important to note that in this model the small-sample corrected degrees of freedom is greater than 4 (i.e., 54), suggesting that the *p*-value for the associated *t*-test accurately reflects the type I error (Tanner-Smith et al., 2016).

One should observe that our findings from the RVE analysis are broadly consistent with those from previous meta-analyses. Storey and Zhang (2021) concluded that due to Covid-19 students lost, on average, 0.15 standard deviations of learning, König and Frey (2022) found average losses of 0.175 standard deviations, Betthäuser et al. (2023) estimated average losses at 0.14 standard deviations, and Di Pietro (2023) calculated average losses of

[5] The *robumeta* command in Stata is employed. An intercept-only model is run where the estimate of the meta regression constant is equal to the unconditional mean effect size across studies. With this command, it is possible to specify a value for *rho*, the expected correlation among dependent effects. Following Tanner-Smith and Tipton (2013), we use different values of *rho* ranging from 0 to 1 in intervals of 0.1 in an attempt to check the consistency of results. All models yield the same outcome regardless of the specified value of *rho*.

around 0.19 standard deviations[6]. Two considerations help put these results into perspective. First, one may notice that the delayed learning suffered by students as a result of Covid-19 school closure is roughly comparable to that experienced by their peers after major natural disasters. For instance, Sacerdote (2012) found that in the spring of 2006 students who were displaced by Katrina and Rita hurricanes saw their test scores fall by between 0.07 and 0.2 standard deviations. A similar result, though of a smaller magnitude, is obtained by Thamtanajit (2020). He showed that in Thailand floods reduced student test scores by between 0.03 and 0.11 standard deviations, depending on the subject and educational level. Second, following Hanushek and Woessmann (2020), a learning deficit of about 0.186 standard deviations can be considered to be equivalent to the loss of just over half of a school year[7].

3.2 Moderator analyses

The next step in the meta-analysis is to attempt to investigate factors that may explain the observed variation in effect sizes given that, as shown above, I^2 is equal to 100%. In fact, when I^2 is greater than 75% heterogeneity is high and this justifies moderator analyses (Higgins et al., 2003).

Table 4 reports the results of the moderator analyses[8]. It is interesting to observe that 95% CI of each subset of all moderator variables is negative and exclusive of zero, indicating that the pandemic, on average, had a consistent, statistically significant, detrimental effect on student achievement. Additionally, one should note that the categories of all moderator variables, with the exception of "Tertiary", are highly heterogeneous (I^2>99%). This means that practically all between-study heterogeneity is still unexplained.

a) Subject areas

There are a total of 400 effect sizes that provide information on the subject being assessed. Of the 400 effect sizes, 211 represent humanities, 178 represent math/science and 11 represent a mix of these two subjects.

The average effect size for math/science (*d* = -0.128) is found to be larger than the corresponding ones for humanities (*d* = -0.093) and the mix category (*d* = -0.079). While on the one hand this result is consistent with those obtained in the meta-analyses by Di Pietro (2023) and Betthäuser et al. (2023), on the other, it differs because our average effect sizes are not statistically different. The small number of observations in the mix category may have contributed to the overlapping of the confidence intervals and statistical insignificance.

b) Geographical area

There are a total of 400 effect sizes that give information on the geographical area where the relevant sample was collected. Out of the 400 effect sizes, 231 refer to samples drawn from OECD countries that are not part of the EU, while the remaining 169 represent samples drawn from OECD-EU Member States.

Our analysis reveals statistically significant moderating effects of geographical area. Specifically, Covid-19 caused a larger average learning loss in OECD non-EU countries (*d* = -0.139, CI95 = -0.154, -0.123) than in OECD-EU Member States (*d* = -0.069, CI95 = -0.104, -0.034).

A possible explanation for the smaller learning losses experienced by students in OECD EU countries relative to their peers in OECD non-EU countries may lie in differences in their exposure to physical school closure. As expected, Kennedy and Strietholt (2023) show that there is a negative correlation between physical school closure and student achievement in reading. Using data gathered by UNESCO's Institute of Statistics on the duration of Covid-19 physical school closure in many countries around the world, we computed the average number of days schools were closed (partially or totally) in our two groups of countries. While in the OECD EU countries included in our sample schools were physically closed due to Covid-19, on average, for about 245 days, the corresponding

[6] Relevant systematic reviews have also found similar learning deficits. Donnelly and Patrinos (2022) found average delays of 0.13 standard deviations, Zierer (2021) estimated average losses at 0.14 standard deviations, and Hammerstein et al. (2021) reported average deficits of 0.10 standard deviations. Examining only EU countries, De Witte and François (2023) computed an average learning deficit of around 0.11 standard deviations.

[7] They found that the loss of one third of a school year of learning is equivalent to approximately 11% of a standard deviation of lost test results. This finding is broadly consistent with that obtained by Hill et al. (2008) who conclude that a value of Cohen's *d* of 0.4 (with a margin of error of ± 0.06) corresponds to the average annual reading achievement gains in fourth grade.

[8] The RML method is used.

value for OECD non-EU countries is 344 days. Interestingly, this gap widens if a weighted average (taking into account the number of effect sizes for each country within the two groups) is calculated (i.e., 422 days for OECD non-EU countries vs 228 days for OECD EU countries).

Table 4: Results for moderator variables

Moderator variables	Q_B	*K*	d_+	*95% CI*	I^2
Subject area	4.46				
1. Humanities		211	-0.093	-0.112 -0.074	100.00
2. Math/Science		178	-0.128	-0.160 -0.097	100.00
3. Mix		11	-0.079	-0.124 -0.034	99.84
Geographical area	12.75*				
1. OECD EU Member States		169	-0.069	-0.104 -0.034	100.00
2. OECD non-EU Member States		231	-0.139	-0.154 -0.123	100.00
Level of education	1.87				
1. Primary		268	-0.104	-0.123 -0.084	100.00
2. Secondary		123	-0.117	-0.153 -0.081	100.00
3. Tertiary		9	-0.144	-0.203 -0.086	45.24
Type of publication	0.38				
1. Peer reviewed journal articles		81	-0.129	-0.203 -0.056	100.00
2. Other studies		319	-0.105	-0.119 -0.092	100.00
Year of publication					
2020	9.95*	37	-0.120	-0.153 -0.087	100.00
2021		243	-0.087	-0.107 -0.067	100.00
2022		71	-0.156	-0.218 -0.093	99.99
2023		49	-0.151	-0.200 -0.102	94.91
Timing of student assessment during Covid-19	13.72*				
2020		195	-0.076	-0.099 -0.053	100.00
2021 or later		205	-0.139	-0.163 -0.115	99.94

Note: Q_B refers to the moderator contrasts, K = Number of effect sizes, d_+ = average value of effect size, 95%CI = 95% Confidence Interval for the average value of effect size, I^2 refers to the heterogeneity of each group; * $p < 0.05$.

c) Level of education

There are a total of 400 effect sizes that provide information on the education level of assessed students. Out of the 400 effect sizes, 268 represent primary students, 123 represent secondary students and 9 represent tertiary students.

Q_B turns out not to be significant in level of education (Q_B=1.87, p >.05), meaning that the impact of the pandemic on student performance is not different across primary, secondary and tertiary students. This finding is in line with that of Di Pietro (2023). Betthäuser et al. (2023) also find that the impact of Covid-19 on achievement does not statistically differ between primary and secondary students. However, our result needs to be interpreted with caution given the small number of effect sizes related to tertiary students.

d) Timing of student assessment during Covid-19

There are a total of 400 effect sizes that provide information on the timing of student assessment during Covid-19. Out of the 400 effect sizes, 195 refer to assessments that took place in 2020 while the remaining 205 are from assessments that occurred in 2021 or later.

Our analysis indicates that the timing of student assessment during Covid-19 moderates the effect of the pandemic on student performance (Q_B=13.72, p < .05). The average loss in student achievement is smaller in assessments that took place in the early stages of the pandemic (i.e., 2020- d=-0.076) compared to assessments that occurred several months or more than one year after the first lockdown (i.e., 2021 or later- d=-0.139).

Therefore, our results suggest that, on average, students have fallen further behind since returning to the classroom following the pandemic. Many students might have been unable to grasp more complex academic concepts because they missed out on key foundational knowledge as a result of school closure during Covid-19.

The above outcome is consistent with that of Gambi and De Witte (2023) who find that in the Flemish Community of Belgium learning deficits seem to have accelerated over time. Increased teacher shortage caused by the pandemic could have contributed to this situation. Using data from 45 countries, most of which are high-income OECD members, Özdemin et al. (2022) estimate that the impact of the Covid-19 pandemic could erase decades-long gains in adult skills for the affected cohorts unless remedial measures are quickly adopted.

e) Type of publication

Type of publication is not found to have any significant relation with effect sizes for the impact of Covid-19 on student performance (Q_B = 0.38, p >.05). Whether the relevant analysis is included in peer reviewed journal articles (d =-0.129, CI95 = -0.203, -0.056) or in other studies (d =-0.105, CI95 = -0.119, -0.092) do not seem to affect the effect size. In fact, the confidence intervals for "Peer reviewed journal articles" and "Other studies" strongly overlap.

f) Publication year

Our analysis suggests that publication year is a significant moderator of the relationship between Covid-19 and student performance (Q_B = 9.95, p < .05). Studies published in 2022 (d =-0.156, CI95 = -0.218, -0.093) or 2023 (d =-0.151, CI95 = -0.200, -0.102) find larger average learning deficits than studies published in 2020 (d =-0.120, CI95 = -0.153, -0.087) or 2021 (d =-0.087, CI95 = -0.107, -0.067). One possible explanation for this finding is that more recent studies are more likely to examine results of assessments that took place one year or more after the first lockdown, and previous results indicate that learning losses accumulate over time.

4 Additional findings

Next, in an attempt to examine whether the impact of Covid-19 on student achievement does vary by gender and socio-economic background, we searched for relevant effect sizes in the 55 studies included in our sample. We found that separate gender estimates are reported in 15 studies while 27 studies look at the differential impact by socio-economic group. Following the approach of Card et al. (2010), we adopt a 'sign and significance' approach. Therefore, we classify gender effect sizes into three categories: statistically significant larger learning losses for boys, gender learning losses insignificantly different from zero, and statistically significant larger learning losses for girls. Similarly, effect sizes by socio-economic status are also divided into three categories: statistically significant larger learning losses for students from lower socio-economic status, statistically insignificant learning losses by socio-economic status, and statistically significant smaller learning losses for students from lower socio-economic status.

The simple classification 'sign and significance' enables us to draw comparison across studies that use different definitions of socio-economic status[9]. Additionally, in several studies (e.g., Maldonado and De Witte, 2022) exact values for relevant effect sizes and the corresponding standard errors are not provided, but results are presented through graphs. Statistical significance is, however, indicated in the main text.

We collected 34 separate effect sizes for gender and 133 independent effect sizes for lower socio-economic status. Results are reported in Table 5. As for gender, the majority of effect sizes (i.e., 58.8%) support the hypothesis that the effect of the pandemic on student achievement did not statistically vary by gender. This finding is in line with the conclusion of De Witte and François (2023). They observe mixed evidence about the gender effects of Covid-19 on student performance. Table 5 also shows that most effect sizes (i.e., 54.1%) are associated with statistically significant larger learning losses for students from lower socio-economic status. While such an outcome is in line with previous studies (e.g., Betthäuser et al., 2023), one should note that it does not appear to be supported by an overwhelming body of evidence as the proportion of statistically insignificant effects (i.e., 37.6%) is quite high.

Table 5: Relation between the educational impact of Covid-19 and gender/socio-economic status

Gender	Statistically significant larger learning losses for boys	Gender learning losses statistically insignificant	Statistically significant larger learning losses for girls
	14.7%	58.8%	26.5%
Socio-economic status	Statistically significant larger learning losses for students from lower socio-economic status	Statistically insignificant learning losses by socio-economic status	Statistically significant smaller learning losses for students from lower socio-economic status
	54.1%	37.6%	8.3%

[9] A range of different definitions of socio-economic status is used. Some of them are based on parental income (e.g., Birkelund and Karlson, 2021), parental education (e.g., Engzell et al., 2021), under-represented minorities (e.g., Orlov et al., 2021), eligibility for a free meal (e.g., Rose et al., 2021), language spoken at home different from the language of instruction (e.g., Gambi and De Witte, 2022).

5 Remedial policies

As shown in Table 6, a number of different initiatives have been adopted in several EU Member States in order to help students catch up from the learning losses suffered due to Covid-19. These include: tutoring programmes, summer schools, measures designed to strengthen parental engagement, extension of school time, etc. While several studies (e.g., Kortekaas-Rijlaarsdam et al., 2022) carry out a literature review in an attempt to investigate the effectiveness of such provisions based on pre-Covid-19 experiences, very little research is so far available on the success of policies that have actually been implemented during the pandemic. However, this limited evidence would seem to suggest that online tutoring (individual or in small groups) is especially beneficial to students from less advantaged backgrounds. Arriola et al. (2021) evaluate "Menttores", an innovative programme providing free, online, two-to-one afterschool tutoring for less advantaged children who have been hardest hit by the pandemic in Spain. Menttores was addressed to pupils aged 12 to 15 and lasted 8 weeks, with three 50-minute sessions a week. The majority of tutors (i.e., about 87%) were qualified secondary school teachers. Using a robust scientific methodology like randomized controlled trial (RCT), it is found that this tutoring programme had a positive impact on student academic performance and improved pupils' socio-emotional well-being and aspirations. Similar evidence about the effectiveness of online tutoring for more vulnerable students comes from Italy. Carlana and La Ferrara (2021) assess the impact of an intervention called "TOP" that provided free individual online tutoring to economically disadvantaged middle-school Italian students during the lockdown. Tutors were university students who volunteered for 3 to 6 hours per week between mid-April and the beginning of June 2020. Again, employing RCT, it is concluded that TOP was successful in boosting students' achievement and substantially improved their socio-emotional skills, aspirations, and psychological well-being.

The important role played by tutoring programmes during Covid-19 is also highlighted by Pérez-Jorge et al. (2020). They find that a group of students from the Faculty of Education of the University La Laguna (Spain) were satisfied with the tutoring models that were adopted in the academic year 2019-20, especially in light of the university's closure due to the pandemic.

Table 6: Examples of Covid-19 educational remedial initiatives in selected EU Member States

Country	Mitigation policies
Belgium	138 summer schools in Flanders in the summer of 2020 190 summer schools in Flanders in the summer of 2021 10 million euro allocated to summer schools in Flanders in the summer of 2022 (The Brussels Time, 2022)
Austria	Corona support package for students- about 3 million additional support hours in the summer and in the winter semester by February 2022 (European Commission, 2022)
Netherlands	Tutoring, extended school time, individual support, homework assistance, exam training, parental engagement European Commission / EACEA / Eurydice, 2022)
Lithuania	Supplementary tutoring between September and December 2021 (Švietimo, Mokslo ir Sporto Ministerija, 2021) Additional teaching assistants in general education for children with SEN
Slovakia	Summer schools and institution of a special fund in 2021 to cover schools' pandemic-related expenses (European Commission / EACEA / Eurydice, 2022)
France	Organization of the Open School summer 2020 programme to increase the teaching time devoted to practical experience (CEDEFOP, 2020)
Italy	Extracurricular small group tutoring for students at risk of school failure (European Commission / EACEA / Eurydice, 2022)
Poland	Rapid-response teams comprising counsellors, school psychologists, tutors, social workers were created by the Ministry of Education and Science[10] to address mental health problems faced by students with learning difficulties following Covid-19

[10] Psychological and pedagogical support programme for pupils and teachers in a pandemic - Ministry of Education and Science - Portal Gov.pl (www.gov.pl)

Portugal	Launch of plan 21|23 Escola+ whose duration is two years and has a budget of 900 million euro (European Commission, 2022a)
Germany	Planning of a comprehensive tutoring program (Freundl, 2021)
Czechia	A large-scale national tutoring plan was launched in September 2021 (European Commission, 2022b)
Luxembourg	Summer school in the summer of 2020 (Pfeiffer, 2020)

However, in spite of the aforementioned remedial policies, results presented in Table 4 indicate that overall, not only have students not recovered from the learning losses, but they have fallen further behind. Four concurrent explanations can be put forward.

First, students might have experienced problems in re-engaging with education activities following the re-opening of schools. There is evidence showing that, after several months of remote schooling, students in the US have become more passive ad feel disengaged from their learning (Toth, 2021). The stress and anxiety stemming from the pandemic are likely to have caused a fall in student motivation and morale. Wang and Liu (2022) perform a meta-analysis looking at the impact of Covid-19 on anxiety symptoms among Chinese university students. They find that anxiety prevalence was higher in later stages of the pandemic compared to early stages (29.1% vs 17.2%). Additionally, the uncertainty of the learning environment under Covid-19 could have also contributed to reduce students' educational aspirations (OECD, 2020a).

Second, as briefly mentioned above, the pandemic is likely to have exacerbated teacher shortage, exerting a negative effect on student achievement. While an increasing number of teachers have left the profession due to increased stress and workload as a result of Covid-19 (Pressley, 2021), there are not enough new teachers replacing them. Covid-19 could have contributed to increase the lack of attractiveness of the teacher profession. Teacher shortage is found to be correlated with poorer student performance in math, reading and science (OECD, 2020b).

Third, evidence from the US shows that planned tutoring programmes did not deliver what they originally intended in terms of student participation as well as in terms of number and duration of sessions. For instance, Carbonari et al. (2022) look at the implementation of tutoring programmes in 12 school districts across 10 states during the school year 2021-22. They find that in several districts the length and number of tutoring sessions turned out to be less than what was initially scheduled.

Fourth, it is possible that those students who most need remedial education are not taking advantage of existing catch-up programmes. Postlbauer et al. (2022) show that in Austria the intention to use remedial measures is strongly affected by family socio-economic background. Parents with a high level of education and a higher social status tend to show more interest for their children to participate in remedial courses.

Finally, evidence from the US suggests that most parents do not seem to understand the long-lasting consequences of the educational impact of Covid-19. A survey conducted in the autumn of 2022[11] shows that only about a quarter of the interviewed parents believe that their children's education is still behind due to the pandemic. This result is consistent with the findings of a similar survey carried out in March 2023[12]. According to this survey, more than 90% of parents think that their child has already or would soon catch up.

[11] https://www.pewresearch.org/wp-content/uploads/2022/10/W115-topline_COVID-impact-on-K-12-new.pdf
[12] https://bealearninghero.org/wp-content/uploads/2023/04/Parents-2023-Go-Beyond-Grades.pdf

6 Conclusions

While there are already a large number of studies on the impact of Covid-19 on student performance, this is a key policy area that requires constant attention and monitoring. It is important to be aware that pupils will not automatically bounce back from missed learning following school closure during Covid-19. The negative effects of the pandemic on student learning are likely to persist without effective remedial policy action and they can have a long-term adverse impact on students and the economy[13].

The meta-analysis carried out in this paper, which combines and summaries results from 55 studies covering 21 OECD countries, supports the conclusion that learning losses risk becoming persistent and are hard to make up. The results of our moderator analyses indicate that students have fallen further behind during the pandemic. On average, learning losses are found to be greater in assessments that occurred several months or more than one year after the first lockdown compared to assessments that took place in the early stages of the pandemic. This outcome contrasts with results found in previous meta-analyses (Di Pietro, 2023; Betthäuser et al., 2023) concluding that students did not lose any additional ground but failed to rebound.

Several explanations can be advanced to explain why pandemic learning losses are getting worse. It might have been hard for many students to go back to in-person classes after the lockdown. Some time may be needed for them to re-adjust to school life and re-engage with face-to-face learning. Covid-19 has resulted in increased teacher shortages, thereby negatively affecting student performance. Evidence from the US suggests also that it is quite possible that some remedial programmes are not producing the intended outcomes. This may be because the intensity and frequency of the remedial actions are not as high as planned or because these initiatives had a lower participation than expected. There are also some signs that a lot of parents in the US seem to underestimate the seriousness of the educational damage created by Covid-19.

However, one word of caution is needed here. Our results do not suggest that investments in education following Covid-19 are ineffective. It takes time for investments in education to deliver results, and most of those assessments which in our analysis are considered to have taken place in later stages of the pandemic have occurred shortly after or even before the adoption of remedial actions. This means that our estimates are unlikely to capture the full effect of these provisions. Such a consideration stresses the importance of closely monitoring changes in learning losses over time by constantly including in the analysis new studies that are more likely to analyse results from more recent assessments. In the spirit of the European Commission's "Learning Lab on Investing in Quality Education and Training"[14] initiative, frequently updated findings may contribute to designing appropriate policies, programmes and reforms which can make EU educational systems more effective, efficient and equitable (European Commission, 2023).

The results of our meta-analysis indicate also that students in OECD EU countries suffered smaller learning deficits than their peers in OECD non-EU countries. This result appears to be somehow in line with that obtained by Di Pietro (2023) who finds that the pandemic made European students lose less ground than their peers in non-European countries, although in his analysis he also considers students from several less developed countries in Africa and South America. The shorter duration of exposure to physical school closure for students in OECD EU countries relative to those in OECD non-EU countries could contribute to explaining why Covid-19 has had a smaller impact on the learning of the former group compared to the latter.

Finally, while our results confirm the findings of previous studies (including meta-analyses) that Covid-19 had, on average, an adverse effect on learning (between -0.11 and -0.17 standard deviations of student achievement), pupils from less advantaged backgrounds were hit especially hard. On the other hand, the collected evidence seems to suggest that are no statistically significant differences in the way the pandemic impacted the achievement of male and female students.

[13] A report published by the World Bank, UNESCO and UNICEF (2021) states that, if learning losses are not recovered, there is the risk that this generation of students could lose 17 trillion dollars in lifetime earnings in present value, which is equivalent to approximately 14% of today's global GDP.

[14] https://education.ec.europa.eu/focus-topics/improving-quality/learning-lab

References

*Articles included in the meta-analysis

Agostinelli, F., Doepke, M., Sorrenti, G., and Zilibotti, F. (2022). When the great equalizer shuts down: Schools, peers, and parents in pandemic times. *Journal of Public Economics*, *206*. https://doi.org/10.1016/j.jpubeco.2021.104574

*Arenas, A., and Gortazar, L. (2022). *Learning loss one year after school closures*. Working Paper #1, ESADE. Retrieved from: https://www.esade.edu/ecpol/es/publicaciones/learning-loss-one-year-after-school-closures-evidence-from-the-basque-country/

Arriola, M., Gortazar, L., Hupkau, C., Pillado, Z., and Roldán, T. (2021). *A high-impact, on-line tutoring programme for disadvantaged pupils in response to Covid-19*, ESADE Policy Report

Baarck, J., D`Hombres, B., and Tintori, G. (2021). *Loneliness in Europe before and during the COVID-19 pandemic*, European Commission, JRC126802.

Bas, G. (2021). Relation between Student Mental Health and Academic Achievement Revisited: A Meta-Analysis. In: *Health and Academic Achievement-New Findings*. edn.: IntechOpen.

*Bazoli, N., Marzadro, S., Schizzerotto, A. and Vergolini, L. (2022). *Learning Loss and Students' Social Origins during the COVID-19 Pandemic in Italy,* FBK-IRVAPP Working Papers 3.

Betthäuser, B.A., Bach-Mortensen, A.M., and Engzell, P. (2023). A systematic review and meta-analysis of the evidence on learning during the COVID-19 pandemic. *Nature Human Behaviour* 7, 375-385. https://doi.org/10.1038/s41562-022-01506-4

*Bielinski, J., Brown, R., and Wagner, K. (2021). *No Longer a Prediction: What New Data Tell Us About the Effects of 2020 Learning Disruptions*. Retrieved from: https://www.illuminateed.com/wp content/uploads/2021/06/LearningLoss_2021_Update_FB_031221.pdf

*Birkelund, J.F., and Karlson, K.B. (2021). *No evidence of a major learning slide 14 months into the COVID-19 pandemic in Denmark*, SocArXiv. Retrieved from: https://osf.io/preprints/socarxiv/md5zn/

*Blainey, K., and Hannay, T. (2021a). *The Impact of School Closures on Autumn 2020 Attainment*, RS Assessment from Hodder Education and SchoolDash.

*Blainey, K., and Hannay, T. (2021b). *The Impact of School Closures on Spring 2021 Attainment*, RS Assessment from Hodder Education and SchoolDash.

*Blainey, K., and Hannay, T. (2021c). *The Effects of Educational Disruption on Primary School Attainment in Summer 2021,* RS Assessment from Hodder Education and SchoolDash.

Blaskó, Z., da Costa, P., and Schnepf, S.V. (2022). Learning losses and educational inequalities in Europe: Mapping the potential consequences of the COVID-19 crisis. *Journal of European Social Policy*, *32*(4), 361–375. https://doi.org/10.1177/095892872210916

Bol, T. (2020). *Inequality in homeschooling during the Corona crisis in the Netherlands: first results from the LISS Panel*. SocArXiv Papers https://osf.io/preprints/socarxiv/hf32q/

Borenstein, M., Hedges, L.V., Higgins, J.P., and Rothstein, H. R. (2021). *Introduction to meta-analysis*. John Wiley and Sons.

*Borgonovi, F., and Ferrara, A. (2022). *A longitudinal perspective of the effects of Covid-19 on students' resilience. The effect of the pandemic on the reading and mathematics achievement of 5th and 8th graders in Italy*. Retrieved from: https://osf.io/94erb/download

Carbonari, M. V., Davison, M., DeArmond, M., Dewey, D., Dizon-Ross, E., Goldhaber, D., Hashim, A., Kane, T. J., McEachin, A., Morton, E., Patterson, T., and Staiger, D.O. (2022). *The Challenges of Implementing Academic COVID Recovery Interventions: Evidence from the Road to Recovery Project. CALDER*. Retrieved from: https://caldercenter.org/sites/default/files/CALDER%20WP%20275-1222.pdf

Card, D., Kluve, J., and Weber, A. (2021). Active labour market policy evaluations: A meta-analysis. *Economic Journal*, 120, F452–F477. https://doi.org/10.1111/j.1468-0297.2010.02387.x.

Carlana, M., and La Ferrara, E. (2021). *Apart but Connected: Online Tutoring and Student Outcomes during the COVID-19 Pandemic*, EdWorking Paper No 21-350. Annenberg Institute at Brown University

CEDEFOP (2020). *France: Covid-19 crisis - ensuring continuity of learning in vocational training*. Retrieved from: https://www.cedefop.europa.eu/en/news/france-covid-19-crisis-ensuring-continuity-learning-vocational-training

Cheung, M.W.L. (2019). A guide to conducting a meta-analysis with non-independent effect sizes. *Neuropsychology Review*, *29*(4), 387–396. https://doi.org/10.1007/s11065-019-09415-6

Cheung, M.W.L., and Vijayakumar, R. (2016). A guide to conducting a meta-analysis. *Neuropsychology Review*, *26*(2), 121–128. https://doi.org/10.1007/s11065-016-9319-z

*Contini, D., Di Tommaso, M.L., Muratori, C., Piazzalunga, D., and Schiavon, L. (2021). *The COVID-19 pandemic and school closure: Learning loss in mathematics in primary education*. IZA Discussion Paper No. 14785.

Cooper, H., and Hedges, L.V. (1994). *The Handbook of Research Synthesis*. Russell Sage Foundation.

*Coskun, K., and Kara, C. (2022). The impact of the COVID-19 pandemic on primary school students' mathematical reasoning skills: a mediation analysis. *London Review of Education*, 20(1), 1-16. https://doi.org/10.14324/LRE.20.1.19.

*De Paola, M., Gioia, F., and Scoppa, V. (2022). *Online Teaching, Procrastination and Students' Achievement: Evidence from COVID-19 Induced Remote Learning*. IZA Discussion Paper No. 15031, Bonn.

De Witte, L., and François, M. (2023). Covid-19 learning deficits in Europe: analysis and practical recommendations. *EENEE Analytical report.* https://doi.org/10.2766/881143.

*Department for Education (2021a). *Understanding Progress in the 2020/21 Academic Year: Complete Findings from the Autumn* Term, London: Department for Education.

*Department for Education (2021b). *Understanding Progress in the 2020/21 Academic Year: Initial Findings from the Spring* Term, London.

*Depping, D., Lücken, M., Musekamp, F., and Thonke, F. (2021). Kompetenzstände Hamburger Schüler*innen vor und während der Corona-Pandemie [Alternative pupils' competence measurement in Hamburg during the Corona pandemic]. *DDS – Die Deutsche Schule*, Beiheft 17, 51–79. https://doi.org/10.31244/9783830993315.03

Di Pietro, G. (2023). The impact of Covid-19 on student achievement: Evidence from a recent meta-analysis. *Educational Research Review*, 39, 100530. https://doi.org/10.1016/j.edurev.2023.100530

Di Pietro, G. (2022). Studying abroad and earnings: a meta-analysis. *Journal of Economic Surveys*, 36(4), 1096-1129. https://doi.org/10.1111/joes.12472

Di Pietro, G., Biagi, F., Costa, P., Karpínski, Z., and Mazza, J. (2020). *The likely impact of COVID-19 on education: Reflections based on the existing literature and recent international datasets*. Luxembourg, Publications Office of the European Union.

*Domingue, B.W., Hough, H.J., Lang, D., and Yeatman, J. (2021). *Changing patterns of growth in oral reading fluency during the Covid-19 pandemic- Policy Brief*. Policy Analysis for California Education (PACE). Retrieved from: https://edpolicyinca.org/sites/default/files/2021-03/wp_domingue_mar21-0.pdf

Donnelly, R., and Patrinos, H.A. (2022). Learning loss during Covid-19: An early systematic review. *Prospects*, *51*, 601-609. https://doi.org/10.1007/s11125-021-09582-6

El Said, G.R. (2021). How Did the COVID-19 pandemic affect higher education learning experience? An empirical investigation of learners' academic performance at a university in a developing country. *Advances in Human-Computer Interaction*. https://doi.org/10.1155/2021/6649524

*Engzell, P., Frey, A., and Verhagen, M.D. (2021). Learning loss due to school closures during the COVID-19 pandemic. *Proceedings of the National Academy of Sciences 118*(17). e2022376118. https://doi.org/10.1073/pnas.2022376118

European Commission (2023). *Investing in education 2023*. Luxembourg: Publications Office of the European Union

European Commission (2022a). *Education and Training Monitor*. *Portugal*. Luxembourg: Publications Office of the European Union

European Commission (2022b). *Education and Training Monitor*. *Czechia*. Luxembourg: Publications Office of the European Union

European Commission/ EACEA (2022). *The impact of the COVID-19 pandemic on the mental health of young people – Policy responses in European countries*, Publications Office of the European Union

European Commission / EACEA / Eurydice (2022). *Teaching and learning in schools in Europe during the COVID-19 pandemic*. Luxembourg: Publications Office of the European Union.

European Commission/ Eurydice (2022). National reforms in school education- Austria. Retrieved from: https://eurydice.eacea.ec.europa.eu/national-education-systems/austria/national-reforms-school-education

*Fälth, L., Hallin, A.E., and Nordström, T. (2021). Corona-pandemins påverkan på lågstadieelevers läsinlärning [The impact of the corona pandemic on primary school students' reading ability]. Stockholm, Sweden. Retrieved from: http://lnu.diva-portal.org/smash/get/diva2:1592434/FULLTEXT01.pdf

Feng, X., Ioan, N., and Li, Y. (2021). Comparison of the effect of online teaching during COVID-19 and pre-pandemic traditional teaching in compulsory education. *Journal of Educational Research*, *114*(4), 307-316. https://doi.org/10.1080/00220671.2021.1930986

*Förster, N., Forthmann, B., Back, M.D., and Souvignier, E. (2023). Effects of the COVID-19 pandemic on reading performance of second grade children in Germany. *Reading and Writing*, 36, 1-27. https://doi.org/10.1007/s11145-022-10379-y

Freundl, V., Lergetporer, P., and Zierow, L. (2021). Germany's education policy during the COVID-19 crisis. *Zeitschrift für Politikwissenschaft*, 31, 109–116. https://doi.org/10.1007/s41358-021-00262-7

Friese, M., Frankenbach, J., Job, V., and Loschelder, D.D. (2017). Does self-control training improve self-control? A meta-analysis. *Perspectives on Psychological Science*, *12*(6),1077-1099. https://doi: 10.1177/1745691617697076

Furuya-Kanamori, L., Barendregt, J. J., and Doi, S. A. R. (2018). A new improved graphical and quantitative method for detecting bias in meta-analysis. *International Journal of Evidence-Based Healthcare*, 16(4), 195– 203. https://doi: 10.1097/XEB.0000000000000141.

*Gambi, L., and De Witte, K. (2023). *The uphill battle: The amplifying effects of negative trends in test scores, COVID19 school closures and teacher shortages*. KU Leuven Discussion Paper Series DPS23.01.

*Gambi, L., and De Witte, K. (2021). *The resilience of school outcomes after the COVID-19 pandemic. Standardised test scores and inequality one year after long term school closure*. KU Lueven Discussion Paper Series DPS21.12.

*Gillitzer, C., and Prasad, N. (2022). *The Effect of School Closures on Standardised Test Scores*. UNSW Business School Research Paper. Retrieved from: http://dx.doi.org/10.2139/ssrn.4291493

*GL Assessment (2021). *Impact of COVID-19 on Attainment: Initial Analysis,* Brentford.

*Gore, J. Fray, L., Miller, A., Harris, J., and Taggart, W. (2021). The impact of COVID-19 on student learning in South Wales primary schools: An empirical study. *The Australian Educational Researcher*, *48*, 605-637. https://doi.org/10.1007/s13384-021-00436-w

*Haelermans, C., Jacobs, M., van Vugt, L., Aarts, B., Abbink, H., Smeets, C., van der Velden, R., and 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*. Maastricht University, Graduate School of Business and Economics. GSBE Research Memoranda No. 021 https://doi.org/10.26481/umagsb.2021021

Hammerstein, S., König, C., Dreisörne, T., and Frey, A. (2021). Effects of COVID-19-related school closures on student achievement- A systematic review. *Frontiers in Psychology*, *12*, 746289. https://doi.org/10.3389/fpsyg.2021.746289

Hanushek, E.A., and Woessmann, L. (2020). *The economic impacts of learning losses*. OECD

Havranek, T., and Irsova, Z. (2017). Do borders really slash trade? A meta-analysis. *IMF Economic Review*, 65(2), 365-396.

*Hevia, F.J., Vergara-Lope, S., Velásquez-Durán, A., and Calderón, D. (2022). Estimation of the fundamental learning loss and learning poverty related to COVID-19 pandemic in Mexico. *International Journal of Educational Development*, 88, 102515. https://doi.org/10.1016/j.ijedudev.2021.102515

Higgins, J.P.T., and Green, S. (2011). *Cochrane handbook for systematic reviews of interventions*. The Cochrane Collaboration. Version 5.1.0 [updated March 2011].

Higgins, J.P.T., Thompson, S.J., Deeks, J. J., and Altman, D.G. (2003). Measuring inconsistency in meta-analyses. *British Medical Journal*, *327*(7414), 557–560. https://doi.org/10.1136/bmj.327.7414.557

Hill, C.J., Bloom, H.S., Black, A.R., and Lipsey, M.W. (2008). Empirical benchmarks for interpreting effect sizes in research. *Child Development Perspective, 2*(3), 172–177. https://doi.org/10.1111/j.1750-8606.2008.00061.x

Hinton, M. (2020). *Why teaching kindergarten online is so very, very hard?* Retrieved from: https://www.edutopia.org/article/why-teaching-kindergarten-online-so-very-very-hard/#:~:text=%E2%80%9CKindergartners%20usually%20need%20a%20lot,her%20students%20online%20this%20year.

Imberman, S.A., and Strunk, K.O. (2023). *COVID-19 hurt kids' math learning more than reading and writing – with the biggest setbacks in fall 2020*. The Conversation, 27/06/2023 Retrieved from: https://theconversation.com/covid-19-hurt-kids-math-learning-more-than-reading-and-writing-with-the-biggest-setbacks-in-fall-2020-204781

*Jakubowski, M., Gajderowicz, T., and Wrona, S. (2022). Achievement of Secondary School Students After Pandemic Lockdown and Structural Reforms of Education System Results from TICKS 2021 Assessment in Warsaw. *Evidence Institute Policy Note 1*, Warsaw. Retrieved from: https://www.evidin.pl/wp-content/uploads/2022/01/POLICY-NOTE-1-2022-EN.pdf

Ji, M., Cohan, D.S., Bell, M.L. (2011). Meta-analysis of the association between short-term exposure to ambient ozone and respiratory hospital admissions. *Environmental Research Letters*, *6*(2), 024006. https:// doi.org/10.1088/1748-9326/6/2/024006.

Kaiser, T., and Menkhoff, L. (2020). Financial education in schools: A meta-analysis of experimental studies. *Economics of Education Review*, *78*, 101930. https://doi.org/10.1016/j.econedurev.2019.101930

Kennedy, A., and Strietholt, R. (2023). *School Closure Policies and Student Reading Achievement: Evidence Across Countries*. Retrieved from: https://files.osf.io/v1/resources/93rgz/providers/osfstorage/64775ddfbf3d0f065fd87111?action=downloadanddirectandversion=2

Kim, L.E., Dundas, S., and Asbury, K. (2023). I think it's been difficult for the ones that haven't got as many resources in their homes': teacher concerns about the impact of COVID-19 on pupil learning and wellbeing, *Teachers and Teaching,* Forthcoming. https://doi.org/10.1080/13540602.2021.1982690

Knapp, G., and Hartung, J. (2003). Improved tests for a random-effects meta-regression with a single covariate. 22(17), *Statistics in Medicine*, 2693-710. https://doi/10.1002/sim.1482

*Kofoed, M.S., Gebhart, L., Gilmore, D., and Moschitto, R. (2021). *Zooming to class? Experimental Evidence on college students' online learning during COVID-19*. IZA Discussion Paper No. 14356.

*Kogan, V. and Lavertu, S. (2021a). *The COVID-19 pandemic and student achievement on Ohio's third grade English language arts assessment*. The Ohio State University. Retrieved from: https://glenn.osu.edu/sites/default/files/2021-09/ODE_ThirdGradeELA_KL_1-27-2021.pdf

*Kogan, V. and Lavertu, S. (2021b). *How the COVID-19 pandemic affected student learning in Ohio: Analysis of Spring 2021 Ohio state tests*. The Ohio State University. Retrieved from: https://glenn.osu.edu/sites/default/files/202110/210828_KL_OST_Final_0.pdf

König, C., and Frey, A. (2022). The impact of COVID-19-related school closures on student achievement- A meta-analysis. *Educational measurement issues and practices*, 41(1), 16-22. https://doi.org/10.1111/emip.12495

*Korbel, V., and Prokop, D. (2021). *Czech students lost 3 months of learning after a year of the COVID-19 pandemic*. Prague: PAQ Research. Retrieved from: Microsoft Word - PAQ_Dopad_pandemie_na_vysledky_zaku_ENG.docx (usrfiles.com)

Kortekaas-Rijlaarsdam, F., Ehren, M., and Meeter, M. (2022). *Catch-up programmes in primary education in the Netherlands: overview of programmes (first tranche) and a literature review of effectiveness of programmes*, Netherlands Initiative for Education Research, VU Learn

*Kozakowski, W., Gill, B., Lavallee, P., Burnett, A. and Ladinsky, J. (2020). *Changes in Academic Achievement in Pittsburgh Public Schools during Remote Instruction in the COVID-19 Pandemic.* Institute of Education Sciences (IES), US Department of Education.

*Kuhfeld, M., Ruzek, E. Johnson, A., Tarasawa, B., and Lewis, K. (2020b). *Technical appendix for: Learning during COVID-19: Initial findings on students' reading and math achievement and growth*. Retrieved from: https://www.nwea.org/content/uploads/2020/11/Technical-brief-Technical-appendix-for-Learning-during-COVID-19-Initial-findings-on-students-reading-and-math-achievement-and-growth-NOV2020.pdf

*Kuhfeld, M., Soland, J. and Lewis, K. (2022). *Test Score Patterns Across Three COVID-19-impacted School Years*. EdWorkingPaper: 22-521, Annenberg Institute at Brown University. https://doi.org/10.26300/ga82-6v47

Kuhfeld, M., Soland, J., Tarasawa, B., Johnson, A., Ruzek, E. and Liu, J. (2020a). Projecting the Potential Impact of COVID-19 School Closures on Academic Achievement. *Educational Researcher*, 49(8), 549-565. https://doi.org/10.3102/0013189X20965918

*Lambropoulos, H., Panagiota, V.S., and Karatzia-Stavlioti, E. (2022). The impact of the COVID-19 pandemic on learning in Greece: Investigation of the University entrance exams. *European Journal of Education Studies*, *9*(4).

Langan, D., Higgins, J.P.T., Jackson, D., Bowden, J., Veroniki, A.A., Kontopantelis, E., Viechtbauer, W., and Simmonds, M. (2019). A comparison of heterogeneity variance estimators in simulated random-effects meta-analyses. *Research Synthesis Methods*, *10*(1), 83–98. https://doi.org/10.1002/jrsm.1316

*Lerkkanen, M.K., Pakarinen, E., Salminen, J., and Torppa, M. (2023). Reading and math skills development among Finnish primary school children before and after COVID-19 school closure. *Reading and Writing*, 1-26. https://doi.org/10.1007/s11145-022-10358-3

Lin, L., and Chu, H. (2018). Quantifying publication bias in meta-analysis. *Biometrics*, *74*(3), 785-794. https:// doi.org/10.1111/biom.12817

*Locke, V. N., Patarapichayatham, C. and Lewis, S. (2021) *Learning Loss in Reading and Math in US Schools Due to the COVID-19 Pandemic,* Istation.

*Ludewig, U., Kleinkorres, R., Schaufelberger, R., Schlitter, T., Lorenz, R., Koenig, C., Frey, A., and McElvany, N. (2022). COVID-19 Pandemic and Student Reading Achievement – Findings from a School Panel Study. PIRLS. *Frontiers in Psychology*, *13*, 876485. https://doi.org/10.3389/fpsyg.2022.876485

Lupas, K.K., Mavrakis, A., Altszuler, A., Tower, D., Gnagy, E., MacPhee, F., Ramos, M., Merrill, B., Ward, L., Gordon, C., Schatz, N., Fabiano, G., and Pelham, W. (2021). The short-term impact of remote instruction on achievement in children with ADHD during the COVID-19 pandemic. *School Psychology*, *36*(5), 313-324. https://doi.org/10.1037/spq0000474

*Maldonado, J. E., and De Witte, K. (2022). The effect of school closures on standardised student test outcomes. *British Educational Research Journal*, *48*(1), 49-94. https://doi.org/10.1002/berj.3754

*Meeter, M. (2021). Primary school mathematics during the COVID-19 pandemic: No evidence of learning gaps in adaptive practicing results. *Trends in Neuroscience and Education, 25*, 100163. https://doi.org/10.1016/j.tine.2021.100163

Moher, D., Liberati, A., Tetzlaff, J., Altman, D.G., and Prisma Group (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *PLoS Med, 6*(7), Article e1000097. https://doi.org/10.1371/journal.pmed.1000097

*Moliner, L., and Alegre, F. (2022). COVID-19 restrictions and its influence on students' mathematics achievement in Spain. *Education Sciences*. *12*(2), 105. https://doi.org/10.3390/educsci12020105

*Moliner, L., Alegre, F., and Lorenzo-Valentin, G. (2022). The COVID-19 pandemic's impact on 9th grade students' mathematics achievement. *European Journal of Educational Research*, *11*(2), 835-45. https://doi.org/10.12973/eu-jer.11.2.835

*Molnár, G., and Hermann, Z. (2023). Short-and long-term effects of COVID-related kindergarten and school closures on first-to eighth-grade students' school readiness skills and mathematics, reading and science learning. *Learning and Instruction*, *83*, 101706. https://doi.org/10.1016/j.learninstruc.2022.101706

Moscoviz, L., and Evans, D.K. (2022). *Learning loss and student dropouts during the COVID-19 pandemic: A review of the evidence two years after schools shut down*. Working Paper 609. Center for Global Development.

Newton, D. (2020). Most teachers say they are not prepared to teach online. *Forbes.* 26/03/2020. Retrieved from: https://www.forbes.com/sites/dereknewton/2020/03/26/most-teachers-say-they-are-not-prepared-to-teach-online/?sh=3a2c70837f2c

OECD (2020a). *Education and COVID-19: Focusing on the long-term impact of school closures*. Paris.

OECD (2020b). *PISA 2018 Results (Volume V): Effective Policies, Successful Schools*. Paris.

*Orlov, G., McKee, D., Berry, J., Boyle, A., DiCiccio, T., Ransom, T., Rees-Jones, A., and Stoye, J. (2021). Learning during COVID-19 pandemic: It is not what you teach, but how you teach. *Economics Letters*, *202*, 109812. https://doi.org/10.1016/j.econlet.2021.109812

Özdemir, C., Reiter, C., Yildiz, D., and Goujon, A. (2022). Projections of adult skills and the effect of COVID-19, *Plos One*, 17(11), e0277113. https://doi.org/10.1371/journal.pone.0277113

Pérez-Jorge, D., Rodríguez-Jiménez, M.d.C., Ariño-Mateo, E., and Barragán-Medero, F. (2020). The Effect of COVID-19 in University Tutoring Models, *Sustainability* 12, 8631. doi:10.3390/su12208631

*Pier, L., Christian, M., Tymeson, H. and Meyer, R. H. (2021). *COVID-19 Impacts on Student Learning: Evidence from Interim Assessments in California. PACE Working Paper,* Policy Analysis for California Education.

Pfeiffer, R. (2020). "*Summer school" a success, especially with primary school students,* RTL 02/09/2020. Retrieved from: https://today.rtl.lu/news/luxembourg/a/1573511.html

Polák, P. (2019). The Euro's trade effect: A meta-analysis. *Journal of Economic Surveys*, *33*(1), 101–124. https://doi.org/10.1111/joes.12264

Postlbauer, A., Helm., C., and Große, C.S. (2022). Educational inequality and COVID-19: Who takes advantage of summer schools and other remedial measures? *Z f Bildungsforsch*, 12, 407–436. https://doi.org/10.1007/s35834-022-00356-4

Pressley, T. (2021). Factors Contributing to Teacher Burnout During COVID-19. *Educational Researcher*, 50(5), 325–327. https://doi.org/10.3102/0013189X211004138

Psacharopoulos, G., Collis, V., Patrinos, H. A, and Vegas, E. (2020). *Lost wages: The COVID-19 cost of school closure*. IZA DP No. 13641, Bonn

*Relyea, J.E., Rich, P., Kim, J.S. *et al.* (2023). The COVID-19 impact on reading achievement growth of Grade 3–5 students in a U.S. urban school district: variation across student characteristics and instructional modalities. *Reading and Writing,* 36, 317–346 https://doi.org/10.1007/s11145-022-10387-y

*Rose, S., Badr, K., Fletcher, L., Paxman, T., Lord, P., Rutt, S., Styles, B., and Twist, L. (2021). *Impact of School Closures and subsequent support strategies on attainment and socio-emotional wellbeing in Key Stage 1*, Research Report, Education Endowment Foundation. Retrieved from: https://educationendowmentfoundation.org.uk/projects-and-evaluation/projects/nfer-impact-of-school-closures-and-subsequent-support-strategies-on-attainment-and-socioemotional-wellbeing-in-key-stage-1

Sacerdote, B. (2012). When the Saints Go Marching Out: Long-Term Outcomes for Student Evacuees from Hurricanes Katrina and Rita. *American Economic Journal: Applied Economics, 4*(1), 109–135. http://dx.doi.org/10.1257/app.4.1.109

*Schult, J., Mahler, N., Fauth, B., and 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. Retrieved from: https://psyarxiv.com/pqtgf/

*Schuurman, T.M., Henrichs, L.F., Schuurman, N.K., Polderdijk, S., and Hornstra, L. (2023). Learning loss in vulnerable student populations after the first Covid-19 school closure in the Netherlands. *Scandinavian Journal of Educational Research*, 67(2), 309-326 http://dx.doi.org/10.1080/00313831.2021.2006307

Sirin, S.R, and Sin, E.J. (2023). Meta-analysis on the relation between acculturation and academic performance: Testing the immigrant paradox. *Educational Research Review*, 39, 100526. https://doi.org/10.1016/j.edurev.2023.100526

*Skar, G.B.U., Graham, S., and Huebner, A. (2022). 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*. Forthcoming. http://dx.doi.org/10.1037/edu0000701

*Spitzer, M.W.H., and 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*(8), e0255629. https://doi.org/10.1371/journal.pone.0255629

Storey, N., and Zhang, Q. (2021). *A meta-analysis of COVID learning loss*. Retrieved from: https://edarxiv.org/qekw2/

Švietimo, Mokslo ir Sporto Ministerija (2021). Ministerija pateikė mokykloms rekomendacijas dėl naujų mokslo metų. Retrieved from: https://www.smm.lt/web/lt/pranesimai_spaudai/ministerija-pateike-mokykloms-rekomendacijas-del-nauju-mokslo-metu

Tanner-Smith, E.E., and Tipton, E. (2013). Robust variance estimation with dependent effect sizes: Practical considerations including a software tutorial in Stata and SPSS. *Research Synthesis Methods*, *5*(1), 13–30. 10.1002/jrsm.1091

Tanner-Smith, E.E., Tipton, E., and Polanin, J.R. (2016). Handling complex meta-analytic data structures using robust variance estimates: A tutorial in R. *Journal of Developmental and Life-Course Criminology*, *2*, 85–112. https://doi.org/10.1007/s40865-016-0026-5

Thamtanajit, K. (2020). The impacts of natural disaster on student achievement: evidence from severe floods in Thailand. *Journal of Developing Areas*, *54*(4), 129-143. https://doi.org/10.1353/jda.2020.0042

The Brussels Time (2022). '*Here to stay' Flanders launches framework for free summer schools*, 06/04/2022. Retrieved from: https://www.brusselstimes.com/215327/here-to-stay-flanders-launches-framework-for-free-summer-schools

*Tomasik, M.J., Helbling, L.A., and 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*(4), 566-576. https://doi.org/10.1002/ijop.12728

Toth, M.D. (2021). *Why students engagement is important in a post-COVD world- and 5 strategies to improve it*. Retrieved from: https://www.learningsciences.com/blog/why-is-student-engagement-important/

Tsolou, O., Babalis, T., and Tsoli, K. (2021). The impact of COVID-19 pandemic on education: Social exclusion and dropping out of school. *Creative Education*, *12*(3). https://doi.org/10.4236/ce.2021.123036

UNESCO (2020). *COVID-19 Educational disruption and response.*

*van der Velde, M., Sense, F., Spijkers, R., Meeter, M., and van Rijn (2021). *Lockdown learning: Changes in online study activity and performance and performance of Dutch secondary school students during the COVID-19 pandemic*. Retrieved from: https://psyarxiv.com/fr2v8/

*Vegas, E. (2022). *COVID-19's Impact on Learning Losses and Learning Inequality in Colombia,* Center for Universal Education at Brookings.

Veroniki, A.A., Jackson, D., Bender, R., Kuss, O., Langan, D., Higgins, J.P.T. Knapp, G. and Salanti, G. (2019). Methods to calculate uncertainty in the estimated overall effect size from a Random-Effects meta-analysis. *Research Synthesis Methods*, *10*(1), 23-43. https://doi.org/10.1002/jrsm.1319.

Wang, X., and Liu, Q. (2022). Prevalence of anxiety symptoms among Chinese university students amid the COVID-19 pandemic: A systematic review and meta-analysis. *Heliyon*, 8(8), e10117. https://doi.org/10.1016/j.heliyon.2022.e10117

Wang, J.K., Xue, H.Q., and Wu, X.F. (2023). Mental health and academic achievement among Chinese adolescents during COVID-19 pandemic: The mediating role of self-regulation learning. *Social Psychology of Education*. https://doi.org/10.1007/s11218-023-09772-4

*Weidmann, B. et al. (2021) *COVID-19 Disruptions: Attainment Gaps and Primary School Responses,* Education Endowment Foundation.

World Bank, UNESCO, and UNICEF (2021). *The state of the global education crisis: A path to recovery*.

Yilanci, V., Gorus, M.S., and Aydin, M., (2019). Are shocks to ecological footprint in OECD countries permanent or temporary? *Journal of Cleaner Production*, 212, 270–301. https://doi.org/10. 1016/j.jclepro.2018.11.299.

Zierer, K. (2021). Effects of pandemic-related school closures on pupils' performance and learning in selected countries: A rapid review. *Education Sciences*, *11*, 252. https://doi.org/10.3390/educsci11060252

Zigraiova, D., Havranek, T., and Novak, J. (2020). *How puzzling is the forward premium puzzle? A meta-analysis*. Working Paper 46, European Stability Mechanism

*Žnidaršič, A., Brezavšček, A., Rus, G., and Jerebic, J. (2022). Has the COVID-19 pandemic affected mathematics achievement? A Case study of university students in social sciences. *Mathematics*, *10*, 2314. https://doi.org/10.3390/math10132314

List of abbreviations and definitions

CEDFOP	European Centre for the Development of Vocational Training
DL	DerSimonian and Laird
EACEA	European Education and Culture Executive Agency
FE	Fixed Effects
OECD	Organisation for Economic Cooperation and Development
PM	Paule-Mandel
RCT	Randomized Control Trial
RE	Random Effects
RML	Restricted Maximum Likelihood
RVE	Robust Variance Estimation
SJ	Sidik-Jonkman
TOP	Tutoring Online Programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNICEF	United Nations Children’s Fund

List of figures

List of tables

GETTING IN TOUCH WITH THE EU

In person

All over the European Union there are hundreds of Europe Direct centres. You can find the address of the centre nearest you online (european-union.europa.eu/contact-eu/meet-us_en).

On the phone or in writing

Europe Direct is a service that answers your questions about the European Union. You can contact this service:

— by freephone: 00 800 6 7 8 9 10 11 (certain operators may charge for these calls),

— at the following standard number: +32 22999696,

— via the following form: european-union.europa.eu/contact-eu/write-us_en.

FINDING INFORMATION ABOUT THE EU

Online

Information about the European Union in all the official languages of the EU is available on the Europa website (european-union.europa.eu).

EU publications

You can view or order EU publications at op.europa.eu/en/publications. Multiple copies of free publications can be obtained by contacting Europe Direct or your local documentation centre (european-union.europa.eu/contact-eu/meet-us_en).

EU law and related documents

For access to legal information from the EU, including all EU law since 1951 in all the official language versions, go to EUR-Lex (eur-lex.europa.eu).

Open data from the EU

The portal data.europa.eu provides access to open datasets from the EU institutions, bodies and agencies. These can be downloaded and reused for free, for both commercial and non-commercial purposes. The portal also provides access to a wealth of datasets from European countries.

Science for policy

The Joint Research Centre (JRC) provides independent, evidence-based knowledge and science, supporting EU policies to positively impact society

EU Science Hub
joint-research-centre.ec.europa.eu

@EU_ScienceHub

EU Science Hub - Joint Research Centre

EU Science, Research and Innovation

EU Science Hub

@eu_science

Publications Office
of the European Union