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Socioeconomic inequalities in opportunities and participation in in-person learning during the Covid-19 pandemic*

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ABSTRACT

Combining a longitudinal national survey of the Chilean school system and administrative datasets, we studied the supply and demand factors associated with the slow in-person return to school in Chile during the Covid-19 pandemic and their effects on socioeconomic disparities. In-person learning in 2021 was limited mainly by supply factors (i.e., sanitary, administrative, and infrastructure restrictions). However, once the supply restrictions decreased, many low-income students and their families did not resume in-person instruction, leading to vast inequalities by schools' socioeconomic characteristics. These inequalities in in-person instruction will expand existing disparities in students' learning and educational opportunities.

1. Introduction

The Covid-19 pandemic caused the most significant disruption of the educational system in recent history. The rapid expansion of the pandemic and the vast uncertainty about the potential effects and transmission dynamics of SARS-CoV-2, the virus that causes Covid-19, led governments to implement several large-scale interventions and regulations to limit transmission (Hsiang et al., 2020; Walker et al., 2020). Extended school closures were one of the greatest disruptions affecting children and adolescents. More than 190 countries canceled in-person instruction during the early months of the pandemic, affecting an estimated 1600 million students (UNESCO, 2021; Willyard, 2021).

Several studies show that the disruption of in-person learning has resulted in significant learning losses (Cooper et al., 1996; Engzell et al., 2021; Jaume and Willén, 2019). The longer the school closures, the greater the adverse effects on learning (Betthäuser et al., 2022; World Bank, UNESCO, & UNICEF, 2021). The consequences of school closures on students' learning have been aggravated by the effects of the pandemic on students' physical and mental health and the increase in unemployment, job instability, and domestic violence (Baron et al., 2020; Gassman-Pines et al., 2022; Hansen et al., 2022; Pereda and Díaz-Faes, 2020; Singh et al., 2020). Further, the impact of school closures goes above and beyond students' learning and cognitive development, affecting the development of socio-emotional skills. School closures in low- and middle-income countries have deprived students of essential services such as nutrition and care (Claro et al., 2022; Haderlein et al., 2021; Van Lancker and Parolin, 2020).

School closures have not affected all students equally. Remote or not in-person modes of instruction have had lower effectiveness among students from ethnic and racial minorities and of lower socioeconomic status (Bacher-Hicks et al., 2021; Dreesen et al., 2020; Haeck and Lefebvre, 2020; Kogan and Lavertu, 2021; Kuhfeld et al., 2022). This has led to substantial learning losses in disadvantaged groups and has expanded existing inequalities (Betthäuser et al., 2022; Domingue et al., 2021). Moreover, the loss of educational contact with students has been greater in low-income communities. High-income students have been less affected by school closures because their schools have better infrastructure than low-income students, and their households have higher social, cultural, and economic capital. These better-off communities have adapted more effectively to the disruption of the educational system (Bacher-Hicks et al., 2021). The increase in learning and educational inequalities will probably have long-term educational, income, and employment consequences (Hanushek and Woessmann, 2020; Parolin and Lee, 2021).

With a better understanding of SARS-CoV-2 transmission, the development of pharmaceutical interventions (e.g., Covid-19 vaccines),

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and improvements in clinical treatments, governments have been adapting more focused and less disruptive interventions to control the pandemic. Research suggests that the risk of infection can be substantially reduced in schools by applying sanitary protocols (Ehrhardt et al., 2020; Ertem et al., 2021; Fukumoto et al., 2021; Hershow et al., 2021) and the protective effect of pediatric Covid-19 vaccines (Jara et al., 2022; Walter et al., 2022). As a result, governments and international organizations have promoted the return to in-person instruction (UNICEF, 2021b). However, the results of school reopenings have been heterogeneous. Countries in Latin America and the Caribbean have had a substantial delay in reopening schools compared to higher-income countries in 2021 (Bello, 2022; UNICEF, 2021a). The factors behind differences in reopening and socioeconomic inequalities in school reopening remain poorly understood.

Chile had a flexible-and-voluntary return to in-person instruction in 2021. Face-to-face learning during the pandemic depended on the students' possibility to attend school in person (supply) and the students' and their parents' decision to return (demand). Determining the impact of the supply restrictions on in-person instruction and demand for in-person instruction by students provides essential information to manage future educational disruptions and identify the students most affected during the pandemic. Understanding the factors associated with in-person return to school by socioeconomic level is vital.

In this manuscript, we study the supply and demand factors associated with students' resuming in-person instruction and the socioeconomic gaps in school reopening in Chile in 2021. We combine various data sources, including data from a novel longitudinal survey with information on school reopening, schools' capacity restrictions, and students' attendance in 2021, and three administrative datasets. We decompose student nonattendance factors into sanitary, administrative, and capacity supply restrictions, on the one hand, and the demand-side factor reflected in students' nonparticipation in in-person instruction, on the other hand. Building on our results, we propose a bundle of policy measures that could help address some of these gaps and respond more effectively to future disruptions in the educational system.

This paper contains five sections. First, we review the literature on school closures during the pandemic. Second, we describe the educational system in Chile and the non-pharmaceutical interventions that affected learning in 2021. Next, we describe the methods and data used for this study. Last, we show the main results, discuss their implications and relation to other studies, and put them in a broader context.

2. Literature review

2.1. Effect of school closures in students' development

The Covid-19 pandemic has remarkably impacted people's lives, including their physical and mental health and economic activity (Asahi et al., 2021; Singh et al., 2020). Extended school closures and limitations to in-person instruction have resulted in the largest disruption of learning in history. Schools closed in 19 out of every 20 countries worldwide for a median of 17 weeks (UNESCO, 2021). Along with school closures, the pandemic brought additional shocks to the students' families, including adverse health impacts (Jain and Dupas, 2022; Kidman et al., 2021) and economic shocks, such as parental unemployment (Gil, Domínguez et al., 2021; Hansen et al., 2022; Sáenz and Sparks, 2020). The consequences of school closures can be profound for students' human capital, well-being, and achievement, with long-term consequences.

Soon after schools closed, researchers began simulating potential learning loss. Kaffenberger (Kaffenberger, 2021) estimated that a three-month school closure could translate into a year of learning loss. Azevedo et al. (2021) forecasted a loss of ten percentage points in reading comprehension for primary school students. These predictions align with empirical research conducted worldwide. A systematic review and meta-analysis in 12 countries found a persistent learning deficit, particularly large among low-income households (Betthäuser et al., 2022). Overall, these studies show that school closures and remote teaching during the pandemic have led to substantial learning losses.

Research suggests that remote teaching is less effective compared to in-person schooling. However, there are relevant global heterogeneities. For instance, studies in the UK and the USA have consistently shown learning losses among primary and secondary school students (Kuhfeld et al., 2022; Kuhfeld et al., 2020; Renaissance Learning, 2021; Rose et al., 2021). In Europe, primary school students show predominantly negative effects. For example, a study in the Netherlands found that learning decreased by 0.08 standard deviations (SD) during an eight-week primary school closure (Engzell et al., 2021). Similar results were found in Belgium and Germany after nine weeks of school closures, with smaller effects in Germany (Maldonado and De Witte, 2020; Schult et al., 2022). In Switzerland, a computer-based evaluation of primary and secondary school students found a slowdown in learning among primary school students following an eight-week shutdown (Tomasik et al., 2021). Finally, Contini et al. (2021) found a 0.19 SD drop in math scores among fourth graders following 15 weeks of school closure in Italy.

The studies conducted in low- and middle-income countries show more mixed results than those conducted in high-income countries. Studies in Burkina Faso, Burundi, Côte d'Ivoire, Senegal, Zambia, and Uganda found no evidence of learning loss associated with school closures (UNESCO, 2022). In contrast, research in Latin America and South Africa found extensive learning losses, aligned with studies in high-income countries. For example, a study in Brazil found a drop in test scores of 0.32 SDs when comparing secondary school students' learning in 2020 (Lichand et al., 2021). A study in Mexico showed that 10 to 15-year-old students experienced a learning loss of 0.34 to 0.45 SD in reading and 0.62 to 0.82 SD in mathematics (Hevia et al., 2022). In South Africa, after a ten-week school closure in 2020 and a delayed school reopening in 2021, a primary students' reading ability survey found they learned half of what was expected based on learning before the pandemic (Shepherd and Mohohlwane, 2021).

Empirical research consistently shows that compounding pre-pandemic learning gaps, learning loss affects the most disadvantaged students (poorest, minorities, and low performers) and is concentrated in the most disadvantaged schools (Curriculum Associates, 2021; Halloran et al., 2021; Kuhfeld et al., 2022; Rose et al., 2021). In the Netherlands, learning losses were 60% higher for students whose parents had lower education (Engzell et al., 2021). Similarly, disadvantaged children were likelier to experience a more significant decline in learning in the United Kingdom and Mexico (Hevia et al., 2022; Renaissance Learning, 2021; Rose et al., 2021). In the USA, achievement gaps between schools with low and high poverty levels widened by 0.10 SD (Kuhfeld et al., 2022). Learning losses were larger in districts with a higher share of Black and Hispanic students (Halloran et al., 2021). In Belgium, inequality within schools rose by between 17% and 20%, with more considerable learning losses in schools with more disadvantaged students (Maldonado and De Witte, 2020). Research also shows that the more extensive school closures, the larger the adverse learning effects (Betthäuser et al., 2022; World Bank et al., 2021).

2.2. Inequality in school reopening modes and student attendance

Schools, districts, and countries have used various learning modes to mitigate SARS-CoV-2 transmission (Kaufman and Diliberti, 2021). Some schools remained closed, others provided remote learning options (partially or fully remote), and some operated entirely using in-person teaching (Henderson et al., 2021).

There have been substantial socioeconomic, racial, and geographical disparities in instruction modalities during the pandemic. Compared to wealthier countries, the poorest countries remained closed substantially longer (UNESCO, 2021). Extant research from the USA shows that more substantial schooling disruptions affected districts and schools with higher proportions of disadvantaged students (Haderlein et al., 2021; Parolin and Lee, 2021). Compared to wealthier school districts, districts serving larger proportions of non-white students in cities and areas with higher poverty were more likely to begin the 2020–21 school year with remote instruction (Hartney and Finger, 2020; Marshall and Bradley-Dorsey, 2020; Schweig et al., 2022). Private schools, which students from higher socioeconomic backgrounds mostly attend, were closed for significantly fewer days than public schools (Fuchs-Schündeln et al., 2021). Similarly, secondary schools were also more severely affected by disruptions than elementary schools. Recent research suggests that school closures during the 2020–2021 school year disproportionately affected districts with less in-person and more virtual learning in the previous academic year (Halloran et al., 2021; Henderson et al., 2021; Oster et al., 2021).

Schools and districts that offered hybrid and virtual instruction rotated between different numbers of days in school and the degree of synchronous instruction (Marshall and Bradley-Dorsey, 2020). Compared to schools with in-person instruction, schools that provided remote teaching were more likely to shorten the school day, cut instructional minutes, and eliminate some non-core courses (Schweig et al., 2022). Private and elementary schools experienced a smaller drop in attendance during the pandemic than public and secondary schools (Fuchs-Schündeln et al., 2021). Overall, private and elementary school students have more effective instructional time. As is well-established, scheduled teaching time is a significant predictor of student achievement (Karweit and Slavin, 1982).

Once schools reopened, parental preferences for remote learning often endured (Meghani et al., 2022). Higher-income parents were more likely to prefer in-person schooling for their children, potentially exacerbating the socioeconomic gap in learning losses due to remote learning (Haderlein et al., 2021). Students from ethnic and racial minorities in the USA were more likely than white students to have remotely started the school year 2020–2021 (George, 2021). Parents from minority groups were less likely to want their children to attend in-person classes.

Despite the growing evidence from high-income countries, little is known about socioeconomic disparities in exposure to in-person learning during 2021 in other settings and to what extent supply-side restrictions determined in-person learning, including sanitary, administrative, and infrastructure restrictions, or demand-side factors, such as parents deciding not to send their children to school.

We address this gap in the literature by examining the Chilean school system during the pandemic. Two characteristics of the Chilean experience are worth highlighting. First, the Ministry of Health limited students' possibilities to return to in-person instruction, especially during the first semester of 2021 (March-July). On July 19, 2020, the Ministry of Health implemented a gradual five-phase program, *Paso a Paso*, with local quarantines only in Phase 1 (Ministerio de Salud, 2020). Phases were defined at the municipal level based on the local epidemiological conditions; schools in municipalities in Phase 2 or higher could voluntarily reopen, whereas those in Phase 1 had to close. When reopening, schools had to comply with strict sanitary protocols (Ministerio de Educación, 2021). The protocol included differentiated schedules for starting and ending classes, mandatory masks, adequate ventilation, frequent hand-washing, and distance rules of at least one meter (3.2 ft.) between students. Mandatory distancing forced schools to restrict the number of students allowed in a classroom (*capacity restrictions*). The principal's decision to reopen was strongly associated with the schools' socioeconomic status. Also, capacity restrictions primarily affected lower-income schools because of their limited infrastructure. Second, even when these schools reopened for in-person instruction, attendance was voluntary in 2021. We provide a more detailed description of the Chilean school system in the Supplementary Material.

3. Materials and methods

3.1. Data

We combined primary and secondary datasets, including a longitudinal national survey of the Chilean school system and administrative datasets. The longitudinal survey is a joint initiative between Universidad de Chile and Pontificia Universidad Católica de Chile in collaboration with the Chilean Ministry of Education to understand how schools operated during the 2021 Covid-19 pandemic (Claro et al., 2022). This voluntary survey was sent monthly between March and November 2021 (nine waves) to all 9450 school principals in the Chilean educational system by email.

The Ministry of Education's guidelines stated that, when reopening, schools should "keep classes as small as possible, allowing for a minimum distancing of 1 m between students in the classrooms" and "ensure a 1-meter distance between individuals at all times" (Ministerio de Educación, 2021, p. 14). Based on these specifications, each month, the survey asked if the school had resumed in-person instruction and, when doing so, the maximum number of students who can attend daily to comply with the government-promoted protocols. This last question is assumed to inform the school's capacity restriction. Moreover, the survey also asked the daily average number of students who attended the school during the week before the survey was sent. As a result, the available data provided monthly updates on school reopening status, capacity restrictions, and the average daily attendance of students.

We complemented this data with three administrative databases. First, we used data from the Education Quality Assurance Agency (in Spanish, Agencia de Calidad de la Educación) to characterize the average socioeconomic level of students in 8286 schools. The Agency estimates socioeconomic status (SES) based on parental education and students' monthly household income. They divide schools into five groups: low, middle-low, middle, middle-high, and high. For ease of analysis, we grouped these categories into low SES (low and middle-low), middle SES (middle and middle-high), and high SES. Second, we used data from the Chilean Ministry of Science, Technology, Knowledge, and Innovation (Ministerio de Ciencia, 2022) to include the phase of *Paso a Paso* plan that the school was in when the surveys were sent. Last, we used data from the Ministry of Education's Academic Performance records between 2015 and 2018 to compare 2021′s attendance levels to those before the pandemic in the same schools. These data provide information on the annual student attendance percentage before the pandemic.

Because the survey responses were voluntary and non-random, we weighted each observation by its representation in the total school system population to obtain results representative of the system. We calculated sample weights following Valliant and Dever (Valliant and Dever, 2011). Using a *logit* model, we estimated the probability of being in the final sample from the complete school system based on observable school attributes (region, urban/rural, education levels, type of secondary education, enrollment size, school administration, and SES). The sample weights correspond to the inverse of such probability. This method also allows partial correction due to non-response in the questions of interest for this study (capacity and attendance).

3.2. Data limitations

Two main limitations arise when using this survey data. First, while health protocol guidelines were uniform across all schools, the extent to which they affected student attendance depended on the school's infrastructure and its staff's ability to optimize the available space. We cannot disentangle the separate contribution of infrastructure conditions and how schools addressed it in shaping capacity restrictions. Nevertheless, our measurement does offer detailed insights into the number of students who could ultimately attend as a result of schools' circumstances and reopening strategies.

Second, our data does not provide insight into the reasons why students did not participate in in-person learning. If school authorities failed to timely and efficiently communicate who and when could attend in person, students' nonparticipation could be misattributed to demand-driven factors. However, representative surveys conducted among families with preschool-enrolled children in Chile revealed that 70% of those who did not send their children to their centers in 2021 did so due to family preferences, with no instances of misinformation regarding attendance possibilities (Valenzuela et al., 2022). Furthermore, as we develop in more detail in the discussion section, school principals in our sample identified family decisions and difficulties as the primary reasons students did not attend when they had the opportunity. Based on this evidence, we assume that the primary driver for students not attending schools when they had the opportunity is related to demand-side restrictions.

3.3. Analysis strategy

Our aim was to determine which supply and demand restrictions were associated with face-to-face instruction. Supply restrictions relate to local epidemiological conditions (schools not allowed to open in Phase 1) (*sanitary restriction*), school principal's decision to not reopen (*administrative restriction*), and the classroom capacity restrictions to comply with distancing protocols (*capacity restriction*). On the other hand, demand restrictions reflect on students not attending when the school had reopened and its capacity allows them to go (*nonparticipation*).

We defined the number of participant schools in socioeconomic group g in wave o as T_{og}, which can be decomposed as:

$$T_{og} = F_{og} + C_{og} + A_{og} \tag{1}$$

where F_{og} represents the number of closed schools in Phase 1, C_{og} the number of closed schools in Phase 2 or higher, and A_{og} the number of opened schools. We defined total school enrollment i as m_i and consider that each school in the sample represents w_i schools in the school system. Thus, Eq. (1) can be rewritten based on the total number of students in each group of schools, that is,

$$\sum\nolimits_{i=1}^{T_{og}} w_i \times m_i = \sum\nolimits_{f=1}^{F_{og}} w_f \times m_f + \sum\nolimits_{c=1}^{C_{og}} w_c \times m_c + \sum\nolimits_{a=1}^{A_{og}} w_a \times m_a \tag{2}$$

Only a fraction of students in open schools can attend, which is equivalent to the capacity set in each case (a_i). Of those that can attend, not all do for various reasons. If we define the number of students attending on an average day as d_i and use convenient zeros, an open school's enrollment equals

$$m_a = (m_a - a_a) + (a_a \quad - d_a) + d_a \tag{3}$$

That is, open school enrollment equals students who cannot attend because of capacity restrictions ($m_a - a_a$) plus those students who do not attend in-person despite being able to do so ($a_a - d_a$) plus those that attend in person. By incorporating Eq. (3) into Eq. (2), we obtain that the total enrollment in the sample can be rewritten as:

$$\sum\nolimits_{i=1}^{T_{og}} w_i \times m_i = \sum\nolimits_{f=1}^{F_{og}} w_f \times m_f + \sum\nolimits_{c=1}^{C_{og}} w_c \times m_c + \sum\nolimits_{a=1}^{A_{og}} w_a \times (m_a - a_a) + \sum\nolimits_{a=1}^{A_{og}} w_a \times (d_a - a_a) + \sum\nolimits_{a=1}^{A_{og}} w_a \times d_a \tag{4}$$

By dividing this equation by the total enrollment of group g in wave o on both sides and adjusting some terms, we obtain that the fraction of students that did not have in-person instruction (*no in-person instruction*) in each wave corresponds to

$$\begin{aligned} no \quad inperson \quad instruction_{og} &= 1 - inperson \quad instruction_{og} = 1 - \frac{\sum_{a=1}^{A_{og}} w_a \times d_a}{\sum_{i=1}^{T_{og}} w_i \times m_i} \\ &= \frac{\sum_{f=1}^{F_{og}} w_f \times m_f}{\sum_{i=1}^{T_{og}} w_i \times m_i} + \frac{\sum_{c=1}^{C_{og}} w_c \times m_c}{\sum_{i=1}^{T_{og}} w_i \times m_i} + \frac{\sum_{a=1}^{A_{og}} w_a \times (m_a - a_a)}{\sum_{i=1}^{T_{og}} w_i \times m_i} + \frac{\sum_{a=1}^{A_{og}} w_a \times (d_a - a_a)}{\sum_{i=1}^{T_{og}} w_i \times m_i} \\ &= sanitary_{pg} + administrative_{og} + capacity \quad restriction_{og} + nonparticipation_{og} \end{aligned} \tag{5}$$

The students with no in-person instruction, as a percentage of total enrollment, can be linearly decomposed as the sum of the percentage of students whose school was in Phase 1 (*$sanitary_{og}$*), the percentage of students whose school did not open in Phase 2 or higher (*$administrative_{og}$*), the percentage of students that could not attend due to school capacity restrictions (*$capacity\ restriction_{og}$*), and the percentage of students that, despite being authorized to attend, did not attend (*$nonparticipation_{og}$*).

Thus, the attendance gap, for instance, between high- and low-socioeconomic-level schools can be decomposed as

$$\begin{aligned} inperson_{high} - inperson_{low} = {} & (sanitary_{low} - sanitary_{high}) + (administrative_{\text{low}} \\ & - administrative_{high}) + (capacity_{low} \\ & - capacity_{high}) + (nonparticipation_{\text{low}} \\ & - nonparticipation_{high}) \end{aligned} \tag{6}$$

Our central analysis decomposes the share of students without in-person instruction from those unable to attend in-person due to supply restrictions (sanitary, administrative, and capacity) and the share of students that did not participate in in-person instruction despite being able to do so (nonparticipation). We also decompose the in-person instruction exposure gap between socioeconomic groups based on the socioeconomic differences in sanitary, administrative, and capacity restrictions and the student participation in in-person instruction, following Eq. (6).

Utilizing a linear decomposition of total enrollment is a descriptive approach, and does not establish causal relationships between variables. However, it offers two significant advantages. Firstly, it focuses on the sequential steps undertaken by each school and student in Chile to resume in-person instruction in 2021: reaching Phase 2 or higher, reopening, implementing attendance frameworks to comply with protocol guidelines, and ultimately attending in person. This approach enables us to examine inequalities at each stage of the reopening process and assess their contribution to overall disparities in students' in-person attendance. Secondly, the strategy's framework is intuitive and yields straightforward results, making it easier to communicate these findings to inform future decision-making processes at the national and school levels.

4. Results

Our final sample consists of 13,441 observations from 4902 different schools out of 8094 schools with available administrative data. Table 1

Table 1
Enrollment's Socioeconomic Composition of the School System and Each Wave's Sample.

		Survey Wave							
SES	School System	Apr 12-16	May 3-7	May 24-28	Jul 14-18	Aug 9-13	Sep 20-24	Oct 18-22	Nov 22-26
Low	41.5%	39.2%	38.1%	38.4%	37.8%	40.6%	40.8%	39.5%	41.8%
Middle	49.0%	51.0%	51.1%	50.3%	49.4%	51.3%	49.7%	52.9%	48.9%
High	9.4%	9.8%	10.9%	11.3%	12.8%	8.1%	9.6%	7.6%	9.3%
N° of schools	8094	2619	2163	1782	1685	1174	1136	1395	1487

Notes. SES denotes socioeconomic status. Own elaboration based on the weighted sample. The eight waves correspond to the following weeks from left to right: April 12-16, May 3-7, May 24-28, June 14-18, August 9-13, September 20-24, October 18-22, and November 22-26.

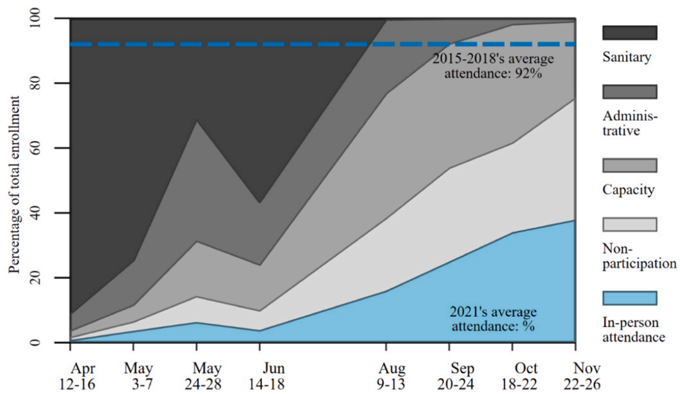

Fig. 1. Average student attendance, supply restrictions (sanitary, administrative, capacity) and nonparticipation for in-person instruction in 2021. Authors' elaboration based on the weighted sample. "Sanitary", "Administrative" and "Capacity" represent sanitary restriction (percentage of schools in Phase 1), administrative restriction (percentage of closed schools in Phase 2 or higher), and capacity restriction (the percentage that cannot attend in person due to school's capacity reductions) respectively. "2015–2018's attendance" corresponds to the average annual attendance across that period.

shows the number and socioeconomic composition of participating schools in each wave, compared to all schools with available administrative data. The descriptive statistics suggest that each wave resembles the characteristics of schools in Chile. Furthermore, this result holds when expanding this analysis to other school characteristics, such as administration type, academic performance level, educational levels offered, and rurality (Please see data description and Table S1 in the Supplementary Material).

Fig. 1 shows the decomposition of total enrollment in the five components in Eq. (4): school was in Phase 1 (sanitary restriction), school is closed despite being in Phase 2 or higher (administrative), the student cannot attend due to capacity restrictions (capacity restriction), the student does not attend despite being able to do so (nonparticipation), and the student attends (attendance). The decomposition is done for each wave, which shows the evolution of each of the five components. To compare in-person attendance rates in 2021 with those expected in a typical year, we also showed the annual attendance average in 2015–2018.

First, in-person attendance was practically null during the first semester of 2021. Between April and June, the maximum attendance occurred in the fourth week of May, when a daily average of 6% of enrolled students attended. The main reason for this was the high incidence of Covid-19 during the first months of the school year and the restrictions implemented in the *Paso a Paso* plan to face this high incidence (sanitary restrictions). Moreover, 91% of enrolled students were in schools in Phase 1 the second week of April. This proportion decreased to 31% by the end of May and increased again to 57% in the third week of June. However, even in the last week of May, when most schools were authorized to resume in-person instruction, 38% of students did not have their schools opened despite being in Phase 2 or higher (administrative restriction). In addition, 17% of the enrolled students could not attend due to capacity restrictions. In total, supply restrictions (sanitary, administrative, and capacity) resulted in an average of 92% of students not attending school daily between April and June.

The significant decrease in infection rates on the national scale, the transition of all municipalities to Phase 2 or higher, and the mandatory reopening since August caused a substantial increase in school reopening during the second semester. In the third week of September, 92% of the students had their school open, extending to 98% in October. Despite the mass reopening of the school system, capacity restrictions prevented many students from participating in daily in-person instruction. Nearly 38% of the students did not attend daily due to capacity restrictions between August and October. This figure dropped to 24% in November after the new school capacity policy was enacted. This policy eliminated the capacity restrictions in classrooms where at least 80% of students completed the first vaccination scheme (two doses separated by 28 days).

As the school system transitioned into mass reopening and gradually eliminated supply restrictions, the daily attendance rate did not reach the allowed capacity. Daily attendance was 16% in the second week of August, progressively increasing to 38% in the fourth week of November, when 76% of the students were allowed to attend simultaneously. Consequently, after a school year with severe supply restrictions of in-person instruction, students not participating in in-

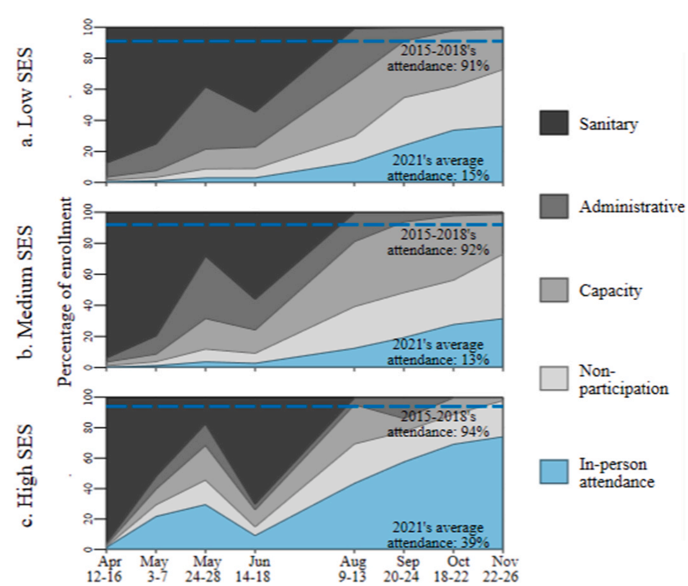

Fig. 2. Average student attendance, supply restrictions (sanitary, administrative, capacity) and nonparticipation in in-person instruction in 2021 by socioeconomic groups. SES denotes socioeconomic status. Own elaboration based on the weighted sample. "Sanitary", "Administrative" and "Capacity" represent sanitary restriction (percentage of schools in Phase 1), administrative restriction (percentage of closed schools in Phase 2 or higher), and capacity restriction (percentage that cannot attend in person due to school's capacity reductions) respectively. "2015–2018's attendance" corresponds to the average annual attendance across that period.

person instruction became a critical factor for low attendance in schools. Between September and November, 47% of the absence of in-person exposure can be attributed to students not attending in-person instruction when they could. On average, 67% of enrolled students did not attend in-person instruction between those months.

There are high disparities in attendance trends by socioeconomic level. Fig. 2 shows the same decomposition as Fig. 1 by socioeconomic groups: low (Panel a), middle (Panel b), and high (Panel c). First, we compare the attendance between socioeconomic groups. The trajectory of attendance among high-SES schools (9.4% of school system enrollment) diverges significantly from that of low- and middle-SES schools, which do not exhibit considerable differences. When sanitary restrictions decreased in May, and throughout the second semester, attendance at high-SES schools exceeded other types schools, accumulating more in-person instruction throughout 2021. On average, during 2021, student attendance in high-SES schools (39% on average in 2021) is three-fold the average attendance of students in middle-SES schools (13%) and 2.6 times the attendance of students in low-SES schools (15%).

Next, we examine the factors associated with each trajectory. Sanitary restrictions were equally important for the three socioeconomic groups throughout the year, although there was greater volatility for high-SES schools during the first semester. On the other hand, administrative restrictions played a pivotal role in the low attendance of students in lower-SES schools, particularly during the first semester, while they were not very relevant in high-SES schools. Specifically, 22% of students in low-SES schools and 19% of students in middle-SES schools could not attend school on a typical day in the first academic semester because their schools did not open even if there were no external restrictions. In contrast, only 7% of students in high-SES schools could not attend in-person under these circumstances. These inequalities in administrative restrictions occurred because substantial proportion of public schools decided not to offer in-person instruction during the first semester (Kuzmanic et al., 2022). Sanitary and administrative restrictions were eliminated for all schools during the second semester. However, administrative restrictions were lifted more slowly in schools with middle and low-SES, where 19% and 32% of students were enrolled in schools that preferred to remain closed even if they had no external opening restrictions.

Between September and November, supply-side restrictions limited in-person instruction through capacity restrictions based on the school's SES. On average, 34% of the students in low-SES schools could not attend daily during the second semester due to capacity restrictions in their schools that were equivalent to 37% of the pre-pandemic level of attendance. Similarly, in middle-SES schools, capacity restrictions represented 42% of their pre-pandemic attendance level during the second semester. This figure equals 13% in high-SES schools. Even with the mass reopening of the school system, students in high- and middle-low-SES schools faced entirely different possibilities to attend in-person instruction regularly due to their schools' capacity restrictions.

Our results suggest a consistent lack of demand for in-person instruction. Students' nonparticipation remained above 20% of the school's enrollment across socioeconomic groups throughout the second semester. However, participation was lower in middle- and low-SES schools, especially during November. In the final week of November, 42% and 36% of the students in middle- and low-SES schools did not attend in-person instruction when they could, compared to 24% of students in high-SES schools.

Next, we analyzed how much of the socioeconomic differences result from inequalities in each supply restriction and how much results from families' unequal participation (demand). Fig. 3 shows the differences in supply restrictions and nonparticipation by SES. Panel (a) shows the gap between low- and high-SES schools, Panel (b) shows the gap between middle- and high-SES schools, and Panel (c) shows the gap between middle- and low-SES schools. When aggregated, these gaps equal the in-person attendance gap (Eq. 6). The differences in Fig. 3 show how much of the SES gaps are explained by supply- and demand-side factors. First, although epidemiological restrictions on school reopening were substantial, they did not substantially differ across SES. Only about 11% of the gaps can be attributed to sanitary restrictions.

The gap between low- and high-SES schools is explained significantly by the administrative restrictions that left low-SES students without in-person instruction between May and August, when their schools could reopen but decided not to. This factor explains 45% of the gap between high- and low-SES schools in 2021. Together with sanitary and capacity restrictions (40%), 96% of the socioeconomic gap was caused by greater supply restrictions in low-SES schools. However, these restrictions primarily occurred during the first half of the year. During the second semester, particularly between September and November, between 24% and 34% of the gap between high- and low-SES schools (34–38% points) was because lower-SES students participated proportionally less when supply restrictions declined.

Similar trends emerge when we decompose the gap between high- and middle-SES. Nonetheless, capacity restrictions (50% of 2021′s gap) are now more critical than administrative restrictions (27% of the gap). The greater importance of administrative restrictions in low-SES schools and capacity restrictions in middle-SES schools is also observed when we analyze the narrow gap between these school groups in Fig. 3, Panel (c).

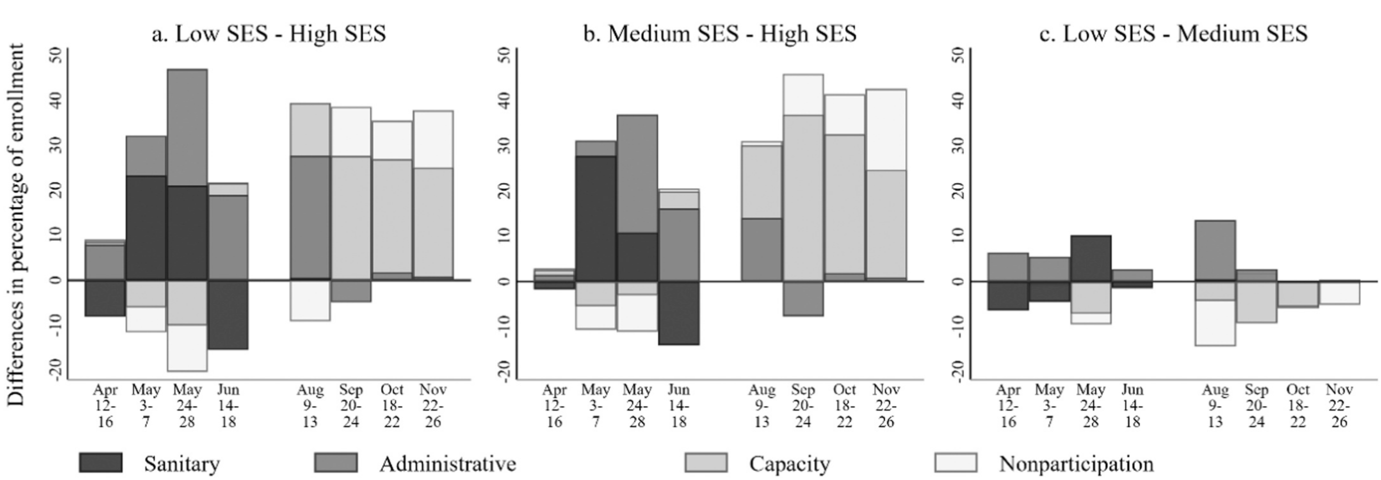

Fig. 3. Socioeconomic differences in supply restrictions and nonparticipation. SES denotes socioeconomic status. Own elaboration based on the weighted sample. "Sanitary", "Administrative" and "Capacity" represent sanitary restriction (percentage of schools in Phase 1), administrative restriction, (percentage of closed schools in Phase 2 or higher), and capacity restriction (the percentage that cannot attend in person due to school's capacity reductions), respectively.

5. Discussion

This study analyzed the return to in-person instruction in the Chilean school system in 2021, following mass school closures in 2020. In-person classes were rare in 2021 in Chile as well. On average, 22% of enrolled students attended in-person instruction, compared to 92% before the pandemic. There were fewer in-person learning opportunities during the pandemic because most schools reopened in 2021 with shorter school days. Even when schools reopened, they offered an equivalent of 50% of the weekly hours available before the pandemic (Claro et al., 2022). By including this component, the average time spent by students in in-person instruction during 2021 represented about one-tenth of the time students spent in in-person instruction before the pandemic.

International evidence unequivocally links pandemic-induced school closures to declining students' academic performance. The slower the return to in-person instruction, the greater the academic setbacks. Consequently, Chilean and Latin American students faced higher risks of experiencing substantial learning losses. On a global scale, losses averaged half a learning year between 2020 and 2021 (Betthäuser et al., 2023; Patrinos et al., 2022). Middle-income countries with extended school closures, like Brazil and Mexico, saw even more significant losses, reaching around 70% of a learning year during the same period (Lichand et al., 2021; Hevia et al., 2022). The present study provides valuable insights into the processes leading to low exposure to in-person learning in a Latin American country such as Chile.

School closures as a non-pharmaceutical intervention to limit Covid-19 transmission were extended until mid-2021 in Chile. This period is substantially longer than school closures in other countries with similar income and among OECD members. In 2021, nearly 30% of students could not attend school in person due to sanitary restrictions at the municipality level. These restrictions implemented by health authorities were among the leading causes that explain the low levels of in-person instruction during the first two years of the pandemic in Chile. Research in 2020 showed that schools could keep SARS-CoV-2 transmission under control with adequate sanitary protocols (Ehrhardt et al., 2020; Ertem et al., 2021; Fukumoto et al., 2021; Hershow et al., 2021). However, schools reopened late and very gradually in Chile, with substantial differences by SES.

The second factor associated with low levels of in-person instruction in 2021 was that school reopening was slower than the national authorities intended. Schools' local authorities resumed in-person instruction later than they could. This delay occurred mainly in the first semester and the beginning of the second semester, with more significant delays in public schools administered by municipal authorities (Kuzmanic et al., 2023). As a result, 17.3% of the students could not receive in-person instruction in 2021 because their school was not open, even if there were no other restrictions.

Beyond school reopening, having students return to classrooms is the main challenge to recovering learning and socioemotional well-being. In Chile, even when schools reopened, students' return was substantially restricted by the maximum number of students allowed by distancing restrictions in school. During the second semester, after the mass reopening of the school system, only two-thirds of students were allowed to attend due to school capacity restrictions. This situation was aggravated by many students not returning to in-person classes. Only about half the students allowed to attend in-person instruction between September and November did so, even if schools were open and capacity restrictions lifted.

In this context, students with lower SES were the most affected. These students had substantially fewer in-person instruction opportunities than high-socioeconomic-level students. Schools with students of lower SES took longer to reopen. Also, because they have the poorest infrastructure, they had to limit their student capacity to comply with distancing protocols. Similarly, lower-SES students participated less in in-person instruction once the supply restrictions were relaxed. This lack of participation became increasingly important to explain the socioeconomic gap in exposure to in-person instruction throughout the year.

Our data provided valuable insights into the supply restrictions on students' in-person attendance during the gradual reopening of schools in Chile in 2021. However, we lack information on the factors influencing students and their families' decision not to return to in-person instruction when it was possible. In September 2021, we asked a subset of schools, facing challenges with student attendance, an open-ended question regarding the main reasons for student absenteeism. The primary cause of absenteeism among the 664 responding schools was fear of infections, mentioned directly in approximately 40% of the responses. Another 20% indicated that families were waiting for higher vaccine coverage or lacked trust in the health protocol guidelines. Other factors, such as transportation limitations, student employment, and student health problems, were mentioned but accounted for less than 10% of the responses. Further research is needed to explore these factors and assess their impact on schools with different student populations.

6. Conclusions

Faced with great uncertainty and potential risks generated by a novel respiratory virus, authorities worldwide decided to close schools as a non-pharmaceutical intervention to gain time while scientists learned more about SARS-CoV-2 and developed a vaccine. However, as the results for Chile suggest, school reopening and the return to in-person instruction was a prolonged process, unable to properly balance the potential benefits of school closures with the costs for students' learning and development and their families. This tension between the urgency to resume in-person instruction and the delay of school communities to respond under uncertainty was observed among authorities, school managers, and families. Following an extended period of school closure, many families were unsure about sending their children to in-person instruction. The reluctance of students and their parents to attend school in person hints at the complex decision-making process under uncertainty and fear.

The large impact of prolonged school closures, particularly among vulnerable populations, underscores the importance of striking a balance between interventions that reduce sanitary risks and the protection and fostering of student development. A more balanced assessment of the trade-offs between the costs and benefits of large-scale non-pharmaceutical interventions to control the pandemic, such as school closures, needs to be reviewed with participation from authorities, scientists, and the educational community. One lesson from this pandemic is that reopening schools is challenging. Our results show that after exceptionally long school closures, most school authorities, students, and their families did not return to in-person instruction, particularly those of low socioeconomic status. This major disruption in education and vast inequalities in in-person instruction will have probably have long-term effects on students' education, income, and employment opportunities, expanding existing inequalities. Now we know that schools should be the last to close and the first to reopen, ensuring that the conditions for this are met in every school, particularly those in vulnerable communities.

We hope the Chilean experience sheds light on the reasons for students' limited in-person instruction during the pandemic, some of the challenges in resuming school attendance, and informs authorities for future crises. Moreover, our findings serve as input for future research assessing the educational impacts of the COVID-19 pandemic worldwide. Learning losses do not only result from school closure and the slow and partial resumption of in-person learning. They were likely exacerbated by students and families postponing their return to classrooms. This result suggests a critical path for future research into the consequences of mandatory school closures and the policy regulations overseeing the return to in-person instruction. Distinguishing between supply and demand factors in addressing learning losses will help improve future emergency response strategies within school contexts.

Authors statement

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Declaration of Competing Interest

None.

Data availability

The data underlying the results presented in the study are available from the Chilean Ministry of Education through the Law on Access to Public Information (No. 20285), which gives citizens the right to obtain documents held by public officials. All Covid-19 related data are publicly available at https://github.com/MinCiencia/Datos-COVID19/.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.ijedudev.2023.102978.

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