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Research in Social Stratification and Mobility 68 (2020) 100524

Contents lists available at ScienceDirect

Research in Social Stratification and Mobility

journal homepage: www.elsevier.com/locate/rssm

Inequality in learning opportunities during Covid-19: Evidence from library takeout

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ARTICLE INFO

Keywords:
Covid-19
Inequality
Library use
Register data
Learning loss
Denmark

ABSTRACT

Research shows that Covid-19 enhanced inequality in families' learning environments. We use register data from Denmark to analyze inequality in families' takeout of digital children's books from public libraries. Our register data, which include more than 55 million observations of families' daily library takeout, show that the socioeconomic gradient in library takeout (by parents' education and income) that existed before the Covid-19 lockdown increased after the lockdown. We also find that the increase in the socioeconomic gradient during Covid-19 was weaker in immigrant than in native families, stronger in families with recent experience in taking out digital materials from the library, and stronger in families with children in the early stages of elementary school. Overall, our results suggest that Covid-19 increased inequality in learning opportunities because better off families were more successful at using libraries during the pandemic than worse off families.

1. Introduction

Across the world, the Corona virus pandemic (Covid-19) shut down schools and forced parents to take charge of their children's schooling. Parents differ in their resources and ability to provide effective home schooling, which means that Covid-19 could enhance existing inequalities in children's learning opportunities. Survey data on home schooling activities collected during the first phases of Covid-19 show that parents of high socioeconomic status (SES; e.g., high education and income) provided more academic support (e.g., help with homework), physical resources (e.g., computers/tablets), and motivational support for their children than parents of low SES (Andrew et al., 2020; Bol, 2020). The consequences of these differences are clear. In the UK, children age 4–15 whose parents belong to the highest income quintile spent on average 5.8 h per day on educational activities during the months of April and May 2020, while those whose parents belong to the bottom quintile spent on average 4.5 h.

In this paper, we analyze inequality in learning opportunities during Covid-19 in Denmark and focus on families' daily takeout of digital children's books from libraries. Unlike existing research, which relies on surveys with parents carried out during Covid-19, we use new data from administrative registers. Our data include information on daily takeout of all types of materials from all Danish public libraries. As we can link register data on library materials to the families that took out the materials, we can map the SES gradient in library takeout before, during, and after the initial phases of Covid-19. In total, our data include more than 55 million family-by-day observations covering the months of February, March, and April of 2020.

While our data are large in terms of the number of observations, we do not claim that they capture all (or even most) dimensions of the learning opportunities parents provide to their children. Nonetheless, our data provide a unique opportunity to study the evolution of inequality in one dimension for an entire population. We argue that library takeout is relevant when analyzing inequality in learning opportunities for three reasons. First, research on families' learning environments highlight reading as a key dimension of these environments (Boonk, Gijselaers, Ritzen, & Brand-Gruwel, 2018; Wilder, 2013), also in Denmark (Jæger & Møllegaard, 2017; Thomsen et al., 2019);. This means that inequality in library takeout is a useful proxy for inequality in broader learning environments. Second, although schools provided online teaching during the Covid-19 lockdown, parents also had to rely on other means to acquire learning materials for their children. Digital materials from libraries provide a free and readily accessible source. Third, Danish libraries traditionally work with schools to provide a digital infrastructure for educational materials, for example via shared online services and logins. This existing infrastructure makes it natural for parents to rely on libraries for home schooling activities during Covid-19.

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https://doi.org/10.1016/j.rssm.2020.100524
Received 12 June 2020; Received in revised form 16 June 2020; Accepted 16 June 2020
Available online 18 June 2020

2. Covid-19 in Denmark

We now briefly outline the timeline of how Danish authorities handled Covid-19. We will use this timeline to define different phases of Covid-19 in the empirical analysis.

The Danish Prime Minister announced a complete lockdown of Denmark on the evening of 11 March 2020, with effect from 12 March. Denmark was more or less completely shut down until 8 May (i.e., for eight weeks), when some parts of the public and private sector gradually began to open. Schools (primary, secondary and tertiary education) closed on 12 March (or as soon as possible thereafter), and gradually began to open from April 15 (but only for children in grades 0 – 5; children in higher grades were allowed back on a limited basis from 18 May onward). Overall, Covid-19 meant that school-age children were absent from school for at least one full month. Public libraries closed on 13 March but continued to offer digital services, in particular digital books. Libraries gradually began to open from 18 May. Daycare institutions for children below school age also closed from 12 March onward and began to open in April.

In the empirical analyses, we define four phases of the Covid-19 lockdown in Denmark: (1) a "pre-lockdown phase" from 1 February to 12 March (i.e., about 1½ months before the lockdown), (2) a "first lockdown" phase from 13 March to 3 April, (3) an "Easter Holiday" phase from 4 April to 13 April, and (4) a "second lockdown" phase from 14 April to 30 April.

3. Data

Our data come from new administrative registers on library takeout. The data, which are available from January 2020 onward and updated daily, include information on all materials in the inventories of all public libraries in Denmark (school and university libraries are not included). Materials in inventories include, for example, books (physical and digital), magazines/periodicals, movies, and music. We also have metadata for each item, for example type, genre, and designated age range. In the empirical analysis, we focus on families' takeout of all digital books designated for children age 0–16 (Appendix Table A1 summarizes descriptive statistics for all variables used in the analysis). Since physical libraries closed during the Covid-19 lockdown, there was no takeout of physical books after 13 March.

Our population consists of families with children, defined as all households with cohabitating children age 0–16 living in Denmark on 31 December 2019. We include children below school age (i.e., age 0 – 5; children normally begin school in the year they turn six) because, like schools, daycare institutions were also closed during the Covid-19 lockdown. As of January 2020, our population consists of 632,354 families with children. We use the register data to link families to their library takeout and SES.

3.1. Variables

3.1.1. Library takeout

Our dependent variable measures the total number of digital children's books each family took out on each day in the period 1 February to 30 April. This means that our dependent variable captures the *flow* of new digital books into families rather than families' current *stock* of digital books. In terms of interpretation, our dependent variable thus captures parents' sustained effort at providing digital books for children before and during the Covid-19 lockdown. Normally, digital (and physical) books can be taken out for 30 days.[1]

[1] Although we can distinguish fiction and non-fiction books in the register data, we focus on all types of books because we cannot meaningfully distinguish between books taken out for schooling activities or for leisure. In any case, fictional books also have educational content, especially when children are learning how to read. To support this decision, we examined the SES gradient in the share of fiction vs. non-fiction books families take out and find that trends and gradients are similar for the two types of books. Moreover, we have analyzed families' takeout of digital books for adults and do not find as marked an increase during the Covid-19 lockdown (which would be a stronger indicator of books for leisure).

3.1.2. SES

We measure family SES by using register information on parents' education and income. For education, we use a dummy variable coded 1 for families in which at least one parent has a college degree (i.e., a degree from a University College [typically 3–4 years on top of high school] or a degree from a University [typically 5 years or more on top of high school]), and zero otherwise. For income, we use a dummy variable coded 1 for families whose total gross income in 2018 (from all sources including salary, public transfers, and capital income) is above the median for all families in the population, and zero if it is below the median. In addition to family SES, we also include a dummy variable for families having immigrant (first/second generation) vs. native background. Finally, we include dummy variables for each day of the week to capture spikes in library takeout during the week.

4. Research design

Our empirical analysis consists of two parts. In the first part, we use graphs to illustrate the evolution of the SES gradient (by education and income) in families' takeout of digital books over the four phases of Covid-19 described above. In the second part, we use family fixed effects models to estimate the SES gradient in library takeout net of time-invariant, omitted characteristics that self-select families into different levels of library use.

5. Results

Before presenting the evolution of the SES gradient in library takeout during Covid-19, we present some basic statistics on families' library use. In the months of 2020 before the Covid-19 lockdown, 25 percent of families took out physical children's books from the library. Moreover, the SES gradient in takeout was substantial: 32 percent of college educated – but only 16 percent of non-college educated – families took out physical books. Similarly, 32 percent of above-median income families took out physical children's books prior to the lockdown, while this was only the case for 20 percent of below-median income families.

5.1. Graphic presentation of the educational gradient in library takeout

Fig. 1a and b summarize families' daily takeout of digital children's books by respectively education and income in the four Covid-19 phases: Pre-lockdown, first lockdown, Easter Holiday, and second lockdown. In the presentation that follows, we focus on the educational gradient in takeout but show that the income gradient is largely identical.

Fig. 1a shows two lines: a darker line for college-educated families and a lighter line for non-college educated families. In the pre-lockdown phase (1 February – 12 March), college-educated families on average took out more digital children's books than non-college educated families (i.e., the darker line is usually above the lighter line). The income gradient during the same phase, shown in Fig. 1b, is very similar to the educational gradient. We note that although the numbers in the graphs look small, they capture families' daily takeout of digital books.

In the first lockdown phase (13 March – 3 April), takeout increased drastically both in college- and non-college educated families and in

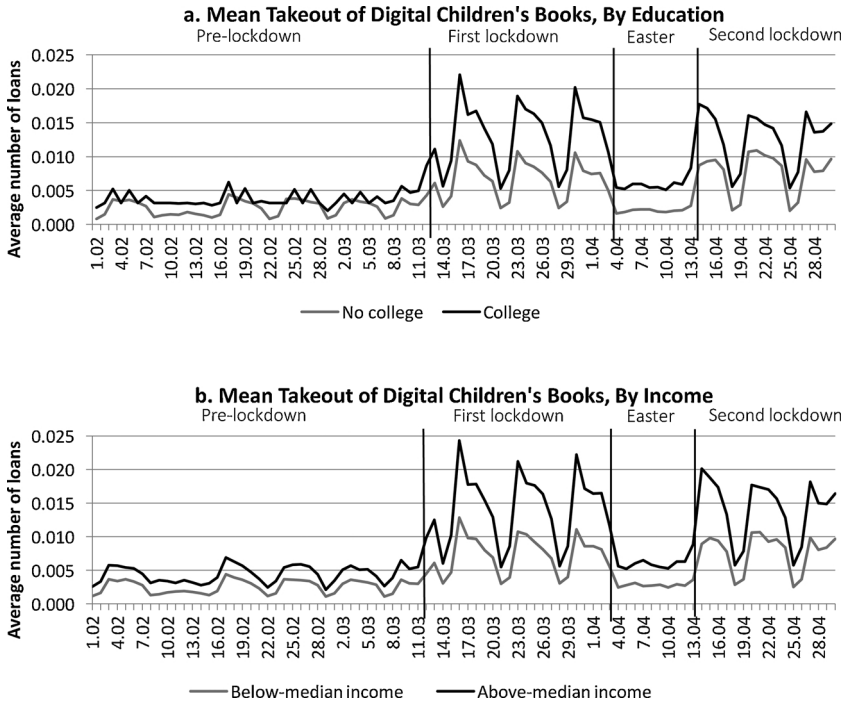

Fig. 1. (a) Mean Takeout of Digital Children's Books, By Education.
(b) Mean Takeout of Digital Children's Books, By Income.

families with above- and below-median income.[2] This secular increase, which exists irrespective of family SES, is consistent with the idea that parents turn to libraries for teaching materials when schools close down. However, the figure also shows that the increase in takeout is substantially higher in college-educated (and above-median income) families than in non-college educated (and below-median income) families. Below, we estimate the quantitative magnitude of this increase.

In the Easter Holiday phase (4 April – 13 April), digital takeout remained stable for around one week in which most families were on holiday. Nevertheless, the SES gradient remained higher in the Easter Holiday phase than in the pre-lockdown phase because college-educated (and above-median income) families stabilized at a higher level of takeout than before the lockdown, while non-college educated (and below-median income) families reverted to the level they had in the pre-lockdown phase.

Finally, in the second lockdown phase (14 April – 30 April) we observe the same pattern as in the first lockdown phase: takeout increased drastically, more so in college-educated and above-median income families than in non-college educated and below-median income families.

5.2. Regression estimates of the SES gradient in library takeout

We now use statistical analysis to back up our visual interpretations of Fig. 1a and b. Table 1 summarizes results from family fixed effects regressions of families' daily takeout of digital children's books during the different phases of Covid-19. We present standardized results (i.e., expressed in standard deviation changes in daily takeout of digital children's books) to facilitate interpretation and note that all empirical estimates in Table 1 are significant at $p < .001$.

Model 1 shows the standardized difference in takeout of digital children's books when we compare all three post-lockdown phases with the pre-lockdown phase. The estimate of .048 shows that takeout increased by around 5 percent of a standard deviation after the Covid-19 lockdown (in absolute terms, this effect is equivalent to .006 digital children's books more per family per day or twice the pre-lockdown daily average of .003 books). Model 2 adds interaction effects between these main effects and the dummy variable for all three post-lockdown phases. Results show that families with college education (.023) and

Table 1
Standardized Results from Fixed Effects Regressions of Takeout of Digital Children's Books During Covid-19.

Model	Baseline results		Results by phase	
	1	2	3	4
Post lockdown period (vs. pre-lockdown)	.048 (.000)	.023 (.001)		
Total-lockdown*college		.023 (.001)		
Total-lockdown*income		.027 (.001)		
First lockdown (vs. pre-lockdown)			.059 (.000)	.027 (.001)
First lockdown*college				.028 (.001)
First lockdown*income				.032 (.001)
Easter Holiday (vs. pre-lockdown)			.010 (.000)	−.003 (.001)
Easter Holiday*college				.016 (.001)
Easter Holiday*income				.006 (.001)
Second lockdown (vs. pre-lockdown)			.058 (.000)	.033 (.001)
Second lockdown*college				.019 (.001)
Second lockdown*income				.031 (.001)
N	56,369,610	52,915,230	52,915,230	52,915,230

Notes: All estimates significant at $p < .001$. Models also control for immigrant status and day of the week.

[2] We also observe "spikes" in takeout on Mondays. We control for these spikes in the regression models presented below.

Table 2
Standardized Results from Fixed Effects Regressions of Takeout of Digital Children's Books During Different Phases of Covid-19, by Subsamples.

Model	Immigrant status		Recent use of platform		Age groups (min one child)		
	Native	Immigrant	No	Yes	0 − 5	6 − 10	11 − 16
	5	6	7	8	9	10	11
First lockdown	.027	.030	.023	.070	.015	.053	.036
	(.001)	(.001)	(.000)	(.003)	(.001)	(.001)	(.001)
First lockdown* college	.032	.007	.016	.062	.020	.064	.034
	(.001)	(.002)	(.000)	(.004)	(.001)	(.002)	(.001)
First lockdown* income	.031	.027	.022	.043	.033	.047	.018
	(.001)	(.002)	(.000)	(.003)	(.001)	(.002)	(.001)
Easter Holiday	−.003	−.001[a]	.007	−.079	.000[a]	.000[a]	−.008
	(.001)	(.002)	(.001)	(.004)	(.001)	(.002)	(.001)
Easter Holiday*college	.017	.014	.010	.073	.016	.032	.013
	(.001)	(.002)	(.001)	(.005)	(.001)	(.002)	(.001)
Easter Holiday*income	.006	.009	.008	.017	.011	.009	.004
	(.0001)	(.003)	(.001)	(.005)	(.001)	(.002)	(.001)
Second lockdown	.032	.040	.027	.093	.018	.060	.046
	(.001)	(.001)	(.000)	(.004)	(.001)	(.001)	(.001)
Second lockdown*college	.022	−.001[a]	.011	.026	.012	.042	.029
	(.001)	(.000)	(.001)	(.004)	(.001)	(.002)	(.001)
Second lockdown*income	.031	.020	.021	.040	.030	.045	.017
	(.001)	(.000)	(.001)	(.004)	(.001)	(.002)	(.001)
N	46,520,820	6,394,410	43,321,860	9,593,370	23,072,400	21,231,900	25,904,250

Notes: All estimates significant at $p < .001$ or better except those marked with [a] that are not significant at $p < .05$. Models also control for day of week.

families with above-median income (.027) increased takeout more than families without college education and below-median income, thereby confirming our earlier finding that Covid-19 increased inequality. In model 3, we include dummy variables for each lockdown phase and find that the increase in takeout was largest in the first and second lockdown phases and smallest in the Easter Holiday phase. Finally, in model 4 we estimate the SES gradient in each lockdown phase that we also observed in Fig. 1a and b. In each phase (including Easter Holiday), families with college education and those with above-median income increased takeout of digital children's books more than families with less education and lower income.

5.3. Group differences

We end the paper by describing differences across groups in the impact of Covid-19 on inequality. We focus on group differences in three dimensions: (1) immigrant status (native vs. first/second generation immigrant), (2) recent experience using the digital library platform, and (3) age of the children in the family. Our objective is to describe how the evolution of inequality varies across groups during Covid-19. Table 2 summarizes empirical results that, like above, we present in standardized form.

First, in models 5 and 6 we compare results for native and immigrant families. While results from native families (model 5) are very similar to those we found in model 4 for the entire population, results for immigrant families (model 6) show some differences. Most importantly, the educational gradient in takeout of digital children's books is much smaller in immigrant families than in native families, both in the first and second lockdown phase (in the latter the educational gradient is not statistically significant from the pre-lockdown phase). At the same time, the income gradient in immigrant families is similar to the one we found for native families. In sum, it seems that differences in immigrant families' income are more strongly associated with inequality in library use during Covid-19 than are differences in education.

Second, in models 7 and 8 we compare results for families that did (not) have recent experience with using the digital platform for taking out materials. For this analysis, we split the population into a group that had taken out any type of material via the digital platform in the period prior to the lockdown phase (i.e., the first two and a half months of 2020) and a second group that had not taken out any digital materials. Results from models 7 and 8 show that the SES gradient in takeout (both by education and income) is much higher in families that had recent experience using the digital platform than in families that did not have such experience.

Finally, in models 9–11 we analyze differences in the SES gradient across families with at least one child that is (a) of pre-school age (0 − 5 years old), (b) in the lower grades of elementary school (6 − 10 years old) or (c) in the final grades of elementary school (11 − 16 years old). Results from these models show that families with school age children increased takeout during Covid-19 the most – in particular families with children in the lower grades of elementary school (age 6 − 10) who presumably require the most parental attention during home schooling.

6. Discussion

In this paper we describe inequality in a single dimension of learning opportunities during Covid-19: families' daily takeout of digital children's books from libraries. We analyze data with more than 55 million observations and find strong evidence that inequality increased during Covid-19. High-SES families took out more digital (and physical) children's books before the Covid-19 lockdown than low-SES families. During Covid-19, the baseline SES gradient increased: high-SES families consistently took out more digital children's books than low-SES families in each of the three phases of the Covid-19 lockdown. Our results are in line with other research that documents inequality in home schooling activities during Covid-19 (Andrew et al., 2020; Bol, 2020), but add to this research by documenting that inequality (in one dimension) *increased* during Covid-19. We also document that the SES gradient was different in immigrant compared to in native families, stronger in families that had recent experience in taking out digital materials from the library, and stronger in families with children in the early stages of elementary school.

Acknowledgements

We gratefully acknowledge funding from the Velux Foundations (Grant No. 00017000) for the research presented in this paper. We thank Statistics Denmark for providing the register data on library takeout, and Kristian Karlson and Merlin Schaeffer for comments on an earlier version of this paper.

Appendix A

Table A1
Summary Statistics.

	Mean	Std. dev.	N
Daily takeout of children's digital books	.007	.121	56,911,860
College degree (highest within household)	.592	.491	56,369,610
Family income (above/below median)	.500	.500	53,092,980
Immigrant status	.126	.332	56,911,860
Any takeout of digital materials from 1 January – 12 March 2020	.176	.381	56,911,860
At least one child age 0 − 5	.442	.497	56,911,860
At least one child age 6 − 10	.398	.489	56,911,860
At least one child age 11 − 16	.482	.500	56,911,860

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