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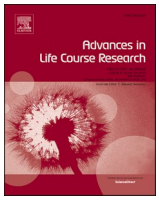

Parental stress and working situation during the COVID-19 shutdown – Effects on children's skill development

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ABSTRACT

Objective: This study examines whether parental emotional distress during the first pandemic-related school shutdown in 2020 in Germany affected the development of primary school students' mathematical skills and investigates changes in parents' working conditions as triggers of cascading stress processes.
Background: The Family Stress Model (FSM) explains the mechanisms that mediate between families' structural conditions and children's developmental outcomes. Foundational works for this approach focus on historic events that instigate rapid structural changes which, in turn, undermine families' economic situation. The economic losses trigger stress processes. Research on the COVID-19 pandemic reports heightened levels of parental stress and negative impacts on children's cognitive and socioemotional development. This study examines the role of parental emotional distress during the COVID-19 shutdown on children's cognitive development. Expanding on the classical FSM, we hypothesize that changes in parents' working situation, rather than economic changes, may have triggered family stress processes during the shutdown, as federal support largely cushioned economic cutbacks in Germany.
Method: For the German National Educational Panel Study (NEPS), interviews were conducted with parents, and primary school students in Starting Cohort 1 were tested after the first shutdown in 2020. The database provides rich information from survey waves prior to the COVID-19 pandemic, allowing a longitudinal analysis of a sample of 1512 primary school students with ordinary least squares regression.
Results: Parents' emotional distress during the pandemic had a robust negative effect on students' mathematical skills, even when controlling for prior parenting stress. Changes in parents' working conditions also had an effect on children's test scores, and the negative effect of working from home on the test scores was mediated by parents' emotional distress.
Conclusion: The COVID-19 pandemic was a historic event which, at least in Germany, challenged the mental health of many parents and, in turn, impaired the skill development of primary school students. We introduce the role of changes in working conditions as triggers of such processes.

1. Introduction

In mid-March of 2020, as the first wave of COVID-19 swept across the globe, Germany closed its schools completely to curb the spread of the pandemic. Face-to-face teaching began again in May to June, with smaller groups of students attending school on alternating days. In some federal states, however, there was no regular instruction until the start of the summer break. During the school shutdown, students had to learn at home, instructed by their teachers in distance learning settings, and cared for and supported by their parents (Fickermann & Edelstein, 2021). Thus, the shutdown not only affected schools but also care arrangements. Furthermore, parents not only had to provide additional learning support and childcare, but also faced profound changes in their working lives. Many employees in Germany switched to working from home or worked reduced hours (Alon et al., 2022; Knize et al., 2022). In addition, measures such as social distancing to combat the pandemic further affected how families were able to organize childcare and work. Depending on the family's structural characteristics and unexpected challenges, parents were exposed to a multitude of stressors affecting their mental health.

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For all these reasons, the COVID-19 pandemic can be considered a historic event that had a disruptive impact on the ways people learned, worked, and lived during that time (Mas, 2021). Over and beyond that, from a life-course perspective, the pandemic is expected to have long-term consequences in many life domains (Settersten et al., 2020).

In public discussions on the potential impact of school shutdowns, concerns were expressed at an early stage that the lack of classroom instruction would lead to learning losses and put children's education at risk (Azevedo et al., 2021). Increasing social disparities were expected, as pre-pandemic research emphasized the growing role of families' socioeconomic status and the home learning environment for children's skill development in phases without regular schooling (Skopek & Passaretta, 2021; see also the US discussion on summer setback by von Hippel et al., 2018).

Empirical investigations harnessing the potential of cohort comparisons and trend analyses in the German context partly confirmed negative developmental effects for the cohort in schooling during COVID-19 in comparison to cohorts tested before the pandemic with regard to school-related skills (for reading see Ludewig et al., 2022; for mathematical skills (but not for reading) see Depping et al., 2021; Schult et al., 2022). Additionally, recent international meta-analyses have revealed that learning losses were not evenly distributed across students with different social backgrounds and also differed by school subject and age. Children from low socioeconomic status (SES) families were more affected than children from high SES families (Betthäuser et al., 2023); learning losses were higher in mathematics than in reading (Betthäuser et al., 2023; Di Pietro, 2023), and younger students accumulated more learning deficits than older students (König & Frey, 2022; no age difference reported in Betthäuser et al., 2023).

Life-course approaches are often utilized to explore the impact of historical events on children's developmental outcomes (e.g., Mistry et al., 2022). From a life-course perspective, "historical forces shape the social trajectories of family, education, and work, and they in turn influence behavior and particular lines of development" (Elder, 1998, p. 2). This approach builds on the tenet of the developmental timing of sociohistorical events, which leads to differential outcomes of the same macro level event. In a study on the developmental effects of the Great Depression in the United States (US), Elder & Caspi (1988) reported that younger children were more vulnerable for long-term detrimental outcomes in comparison with those who experienced the economic crisis in late childhood or adolescence. Another tenet of the life-course approach is the idea of linked lives, according to which children's experience of sociohistorical events is intertwined with the experience of their significant others (Elder, 1998). This interactional relation can be characterized by support, but can also cause social strain (Almeida & Wong, 2009).

In the early phase of the pandemic, sources of supportive relationships were compromised, as school closures and social distancing rules reduced interaction with educators and peers to a minimum. Concurrently, the social relationships in families were burdened by parents' requirement to navigate the uncertainties and changes in work life and the childcare situation (Cheng et al., 2021). There is a considerable body of research on the impact of changes in family relations, parents' working life, educational settings, and peer networks in the wake of the pandemic on children's socioemotional development (for an overview see Mistry et al., 2022). However, the impact of the pandemic's disruptions – especially in families – on children's cognitive development has not been sufficiently researched from a life-course perspective yet. We approach this research gap by utilizing the Family Stress Model (FSM; Conger et al., 1992) as a theoretical framework to examine the role of pandemic-related stress in family relationships together with the roles of changes in professional life during the first school shutdown on the child's cognitive development.

Due to massive restrictions in the freedom of movement during the first lockdown and the low age of our children, the concept of family used in our paper is a narrow one and it refers to children residing with at least one co-resident parent in a private household. Whereas stress is a broad term to capture psychological and physiological reactions to demanding, challenging, or threatening stimuli (Deckers, 2018), the theoretical discussion will refer to psychological aspects and here especially to "emotional distress (e.g., depression, anxiety, anger, and alienation)" (Conger & Donellan, 2007, p. 179; Conger, Conger & Martin, 2010, p. 7).

In our study, we first examine the effects of changes in working conditions during the shutdown on parental emotional distress. Second, we investigate the role of changes in working conditions and parental distress processes during the shutdown as risks for the development of primary school children's mathematical skills, as an example for the cognitive domain. Third, we test whether parental emotional distress mediates the effect of changes in working conditions during the shutdown on the development of children's mathematical skills.

1.1. The Family Stress Model (FSM)

The Family Stress Model originates from research on the effects of historic events on children's and adolescents' development. Elder (1974) investigated the impact of the Great Depression (1929–1933) in the US and found short- and long-term effects on adolescents' development in families hit hard by the crisis. Elder and colleagues also found that changes in the parent-child relationship mediated the impact of economic deprivation on child development. Changes in family resources following negative financial events were found to be a stronger predictor of adolescent psychosocial development than social class affiliation or chronic material scarcity (Elder & Caspi, 1988), and younger children were more vulnerable to these changes than older ones (Elder & Cox, 2019).

Based on Elder's seminal work, Conger et al. (1992) developed a formalized model and used it to investigate how the economic downturn in US farming communities in the 1980 s affected adolescents' socioemotional and cognitive adaptation (see Figure A1 in the Supplement). The model assumes that economic hardships such as low income, high debts-to-assets ratios, and negative financial events place economic pressure on families, thus increasing parents' emotional distress and interparental conflicts. These difficult parental conditions result in a less nurturing environment for children, less parental involvement, and more inconsistent or strict parenting, ultimately impairing children's emotional, cognitive, and behavioral development (Conger & Donnellan, 2007). Findings for different age groups, national contexts as well as ethnic and socioeconomic subgroups support the formalized FSM (for an overview, see Masarik & Conger, 2017).

Theoretical and empirical contributions following this line of research have noticeably extended the spectrum of possible causes of parental distress such as chronic poverty (Brooks-Gunn & Duncan, 1997), demographic characteristics (single parenthood, Taylor & Conger, 2017; belonging to an ethnic minority, Emmen et al., 2013), natural disasters (Scaramella et al., 2008) and also child behavior (Chzhen, Howarth, & Main, 2022; also see Abidin, 1992). Beyond the FSM, research on family functioning has identified a broad array of potential triggers for family stress processes beyond economic hardship. The ABC-X models (Hill, 1958; McCubbin & Patterson, 1983) introduced predictable transitions in the life course as possible stressors for families and also unpredictable events, such as the sudden death of a relative, natural disasters, or winning the lottery. "Any new situation or event that requires substantial adjustments can be a cause of stress for individual family members" (Rosino, 2016, p. 1).

1.2. Causes of parental distress during the COVID-19 pandemic

In the context of the COVID-19 pandemic numerous empirical studies have documented a decrease in parents' psychological well-being, expressed by heightened stress, anxiety, and depressive symptoms (see, e.g., Cheng et al., 2021; Racine et al., 2021). Studies have

shown that the extent of the psychological burden on parents during the pandemic varied depending on the families' pre pandemic socio-demographic situation (e.g., single parenting, number and age of children in the household, parents' education, and socio-economic status) and parents' mental health prior to the pandemic (Brown et al., 2020; Li et al., 2022; Vogelbacher & Attig, 2022).

Regarding changes in families' financial situation due to the pandemic, in the case of Germany, the economic consequences of the COVID-19 pandemic seemed manageable. While, in an international perspective, job loss or financial cutbacks during the pandemic were considered the most severe stressors during the pandemic (Gassman-Pines et al., 2020; Brown et al., 2020; Prime et al., 2020), the first shutdown had only a small impact on unemployment in Germany, but significant reductions in working hours were relatively common in Germany, especially among women and to an even greater extent among women with (pre-) school-aged children (Alon et al., 2022). However, the financial consequences of changes in working conditions due to the pandemic were very thoroughly cushioned by federal programs such as the *Kurzarbeitergeld* (federal financial support for employees with reduced working hours; Knize et al., 2022, p. 163). In line with this, Oppermann et al. (2021) reported null effects of financial problems as predictors of perceived pandemic stress in German parents.

As the economic risks were in most cases reduced in Germany, the most dynamic domains of life requiring adaptation during the pandemic were childcare, education, social contact and the parents' working conditions. The requirement to reconcile work and childcare under the obligation of physical distancing affected all parents of young children, even if the impact varied depending on parents' situation and resources that facilitated adjustment to the new situation (Cheng et al., 2021; Langmeyer et al., 2022). Whereas school closures posed an overarching challenge to all families, changes in working conditions differed considerably between families (Zoch, Bächmann & Vicari, 2021) and could lead to conflicting demands between work and childcare in affected parents. Especially parents' working from home could be expected to struggle with the reconciliation of work, childcare and support of distant learning. Recent research provided evidence, that working from home during the pandemic was associated with increased stress in parents (Li et al., 2022; Oppermann et al., 2021), especially for women who were simultaneously responsible for childcare (Graham et al., 2021). Thus, to apply the FSM to the German context during the pandemic, changes in parents' working conditions in combination with childcare obligations have to be added as potential triggers of family stress processes (see Figure A2 in the Supplement). Therefore we hypothesize:

H1. Working from home in contrast to working out of home negatively affected parental emotional distress.

1.3. Consequences of parental distress and working from home during Covid-19

Studies on the consequences of parental emotional distress during the shutdown have reported positive correlations with problems in the parent-child relationship and children's emotional and behavioral difficulties (Spinelli et al., 2020; Stracke et al., 2023), which could lead to problems in child's cognitive development (Iruka et al., 2012; Nievar et al., 2014). Concerning the child's home learning environment during the shutdown, parental emotional distress was negatively associated with parents' ability to offer learning support (Oppermann et al., 2021). From a theoretical perspective, learning support during shutdown could be understood as a cognitively supportive parenting practice that suffers from parental emotional distress (Kalil & Ryan, 2020) and thus mediates the effect of parental distress on children's cognitive development (see Figure A2 in the Supplement). On the other hand, May & Hoerl (2022) found that the time parents spent supporting children in distance learning increased parental stress perception. As working from home enables parents to support their children for longer periods during the day, parental support could also mediate the negative effect of working from home on parental distress. Thus, the causal direction of the association between parental emotional distress and learning support during the shutdown is not fully clear. In contrast, material characteristics of the home learning environment during the shutdown, such as the availability of a quiet place to study, must be assumed to be predictors of parents' emotional distress (Moreland-Russell et al., 2022; Yeung et al., 2002).

Besides the mediation of the effect of family stress on child's cognitive development via parenting practices and child's socioemotional adjustment, the literature also discusses a direct effect. Layte (2017) found a direct effect of parental mental health on children's cognitive abilities based on an analysis of data from the Millennium Cohort Study. Recent research in neuropsychology and psychoendocrinology has corroborated the direct connection between parents' stress, children's stress, and cognitive development.[1]

Based on theoretical contributions and empirical research, it can be suggested that parental emotional distress caused by the COVID-19 pandemic impeded children's cognitive development during the shutdown through different pathways. Children's cognitive development might have been hindered indirectly through the lack of effective parental support in distant learning or detrimental parenting practices, resulting in socioemotional maladjustments that hindered the learning process. Alternatively, parental emotional distress might have had a direct effect by elevating children's stress levels and impairing cognitive functioning:

H2. Parental emotional distress during the shutdown exerted a negative effect on the development of mathematical skills in primary school students.

As we expected working from home to increase parental emotional distress and also hypothesized that emotional distress negatively affected students' mathematical skill development, it can be inferred that working from home should negatively affect mathematical skill development. This effect was expected to be mediated by parental emotional distress, which leads to our third hypothesis:

H3. Working from home exerted a negative effect on the development of mathematical skills in primary school students, mediated by parents' emotional distress.

2. Methods

2.1. Database and analytical sample

The analyses were based on data from Starting Cohort 1 – the Newborn Cohort – of the German National Educational Panel Study (Blossfeld and Roßbach, 2019; NEPS-Netzwerk, 2022). The NEPS is carried out by the Leibniz Institute for Educational Trajectories (LIfBi, Germany) in cooperation with a nationwide network. For Starting Cohort 1, a random sample was drawn from municipality registers in 2012 (Würbach et al., 2016). A total of 3481 families participated in the first wave in 2012/13 (response rate in gross sample 41%), when infants' early cognitive skills and parent-child interaction were assessed at home, and mothers took part in a computer-assisted personal interview. In the years that followed, the main caregivers, most of whom were mothers, were interviewed and the children were tested annually. The

[1] Perry et al. (2022) reported that children's physiological stress was significantly associated with mothers' physiological stress during the COVID-19 pandemic, even when controlling for family income. This association was even stronger than with other COVID-19-related stressors. Prolonged social and psychological stress was found to lead to increased physiological stress, which hindered cognitive development and learning (Whiting et al., 2021).

participation in any part of the survey was and is voluntary.

As we were interested in the consequences of the first shutdown during the COVID-19 pandemic, we focused on data collected in 2020, the ninth wave of the study. Nearly all the children were in second grade during the shutdown. Originally, data collection for this wave started in March 2020 in respondents' homes and was stopped shortly thereafter due to the pandemic-related shutdown. Data collection resumed in June 2020, when parents were interviewed by telephone. The interview included additional questions on the situation during the COVID-19 shutdown. Parents were then asked to consent to their child's participation in online tests, which were conducted with the assistance of interviewers by telephone and monitored using a digital dashboard. A total of 1814 parents took part in the telephone interviews between June and August 2020, and 1640 children participated in the interviewer-assisted online tests between June and October 2020 (93% in July and August 2020). Eighteen of the 1640 children skipped the mathematical skill test completely, and 47 only did part of the test. In 63 cases, technical problems led to unusable data. Thus, our sample consisted of 1512 children.

The children were roughly 8 years of age (m: 99.1 months; sd: 1.51 months), and 50% were girls. In 97% of the cases, the respondent in the parental interview was the biological mother, and in all other cases it was the father, the foster or adoptive mother, or the partner of the parent. For pragmatic reasons, we will refer to all these groups as mothers in the following.

2.2. Dependent variable

Mathematical Skills. The standardized test of mathematical skills consisted of 20 items targeting different content areas (e.g., sets, numbers and operations; space and shape; change and relationship; Petersen et al., 2022) to measures general mathematical competence. The NEPS data center provides estimates of children's latent mathematical abilities scaled according to Item Response Theory (IRT) (Petersen et al., 2022).

2.3. Dependent / independent variable

Parental emotional distress. Information on several aspects of the respondent's – almost always the mother's – mental health during the pandemic was collected in 2020. We used the following nine indicators to build an emotional distress scale: one item on parental stress arising from the provision of learning support during the shutdown ("I was very stressed by the school closure and the demands of homeschooling."; 1 "does not apply at all" to 5 "does completely apply"), three items on depressive symptoms (e.g., "During this time, how often have you felt down and gloomy?"; 1 "very rarely" to 5 "very often"; adapted from the pairfam study; Reim et al., 2022), four items measuring affective well-being (e.g., "How many times have you felt happy?"; 1 "very rarely" to 5 "very often"; adapted from the SOEP study; Richter et al., 2017), and one overall measure of mental health problems ("And now please think about your mental condition – this also includes stress, depression, or your mood in general. When you think of the first few months of the Corona crisis, how would you describe your mental health?"; 1 "very good" to 5 "very poor"). We reversed the positive items. The scale attained good internal consistency (Cronbach's $\alpha = .85$).

2.4. Independent variables

Changes in work situation. All parents employed prior to the shutdown were asked whether they worked more than usual, just as much, or less or whether they stopped working during the first few months of the pandemic. Additionally, the respondents were asked whether they worked at their workplace or from home during the pandemic. A variable with four categories was generated: "not working from home during the shutdown", "working from home during the shutdown (at least part of the time)", "stopped working during the shutdown", and "not working before the shutdown."

In some further analyses, which serve as a robustness check and might shed some additional lights on the mechanisms, we took *child's home learning environment during the shutdown* into account. As indicator of structural characteristics of the household relevant for child's distant learning during the shutdown we used one indicator for material support ("How do you assess your home situation, e.g. a quiet place, for studying at home in the first months of the corona crisis?"; 1 "completely sufficient" to 4 "completely insufficient"). As an indicator for behavioral support with distant learning we rely on parent's self-reported supporting ability ("I could not help my child with the schoolwork"; 1 "does not apply at all" to 5 "does completely apply"; reversed). Due to the coarse measurement of both dimensions of learning support and – in the case of perceived support abilities – the left-skewed distribution of the variable (see Table A3 in the Supplement) and questionable causal-order (see above), both items are not included in the main analyses.

2.5. Control variables

Parenting stress prior to the shutdown. To capture parenting stress before the COVID-19 pandemic, we generated a scale using five items that had been used in 2018: one item to capture depressive symptoms ("How often in the last four weeks did you feel down and gloomy?"; adapted from pairfam study; Reim et al., 2022), one item to capture loneliness ("I often feel alone."; also adapted from pairfam study), and three items to capture parenting stress (e.g., "I am suffering from being restricted to my role as a mother/father"; adapted from the SOEP study; Kantar Public, 2021). After standardization of the items due to different (ranges in) response scales and reversal of positive items, the internal consistency was considered acceptable (Cronbach's $\alpha = 0.68$). In 21 cases, the respondent in 2018 was not the same as in 2020.

Socio-demographic factors. Many socio-demographic variables were collected in every wave, and some were updated if a change had occurred between the current and previous wave. We used the information collected in 2020, i.e. Wave 9. Information from respondents on school and vocational degrees was converted to years of education by the NEPS data center. As an indicator of financial resources, we used information on disposable household income. As households differ in size and age structure, we adjusted the income by the new OECD equivalence scale (Hagenaars et al., 1994) and took the logarithm. To take into account the household structure, we distinguished between single and two-parent households (0 "cohabitation with partner"; 1 "single parent") and the number of children below the age of 14 years in the household ("1 child"; "2 children"; "3 or more children"). The language used at home was dichotomized (0 "only German"; 1 "(also) other languages than German"). The child's sex was coded 0 "male" and 1 "female". The age of the target child was measured in months at the time of testing in 2020.

Children's skills prior to the shutdown. We controlled for scores in standardized mathematical and reasoning tests conducted in 2018, shortly before the start of primary school. The mathematical test rested on the same assumption as the test conducted in 2020, and reasoning was measured with a matrices test (Weinert et al., 2019). The child's receptive vocabulary (an important predictor of early numeracy; see, e.g., Purpura et al., 2011) was measured in 2019, when nearly all students were in first grade, using an adaptation of the Peabody Picture Vocabulary Test (PPVT; Lenhard et al., 2015). All tests conducted in 2018 and 2019 were administered on a tablet PC at home in the presence of an interviewer. In addition, we used the parents' assessment of their child's mathematical skills in comparison with peers of the same age in 2019 ("How do you assess the following abilities and skills of <name of target child>? Please compare <name of target child> with other children of the same age. Math skills, e.g., ability to handle numbers and quantities."). As a characteristic of the child that could affect parents' emotional distress and skill development, we used school-related

autonomy, collected in the parents' interview in 2019 with three items (e.g., "<Name of target child> does most of her homework on her own"; Cronbach's α = 0.77).

As the curricula, start and end of the school year, specific measures to combat the COVID-19 pandemic, and the timing and organization of school reopening differed slightly between Germany's 16 federal states, we captured each state with a binary variable.

2.6. Missing values and imputation

We fully imputed missing values in parents' survey data and in children's test results prior to the pandemic 10 times using chained equations. The imputation model included all information used later in the regression analysis plus some additional variables such as the parents' highest value on the International Socio-Economic Index (ISEI), the child's performance in mathematical tests in Wave 5, and characteristics of the home learning environment during the shutdown. To facilitate comparison of effect sizes in the subsequent analyses, all continuous variables were z-standardized before the imputation. The number of valid cases, i.e., non-missing data, in the continuous variables is shown in Table 1. As the share of missing data in the categorical variables was less than 1%, and 0% for most variables, we do not show this information in the table.

All syntax files allowing for replication of data preparation, imputation, and model estimation are available at https://osf.io/fyc7m/. The software used was Stata 17.

2.7. Sample description

In our (multiple imputed) sample, 45% of all mothers were working from home; 29% were working out of home. Eighteen percent of mothers were not working before the shutdown; 8% stopped working during the shutdown (see Table A2 in the Supplement for the distribution of parental emotional distress, children's skills, and socio-demographic characteristics according to working conditions during the shutdown). Eleven percent of the mothers did not reside with a partner and are referred to in the following as single parents. In 21% of the households, there was only one household member under the age of 14 (the child taking part in the test). In 58% of the households, there were two, and in 21% of the households there were three or more children under 14 years of age. German was the only family language in 81% of the participating households.

Descriptives for all continuous variables are presented in Table 1: first, for the data prior to standardization and imputation of missing values and, second, for the standardized and imputed variables. The scale for parental emotional distress in Wave 9 ranged from 1 to 5, and the mean before standardization and imputation was 2.76, indicating a medium perceived emotional distress during the shutdown. Bivariate correlations of the variables are available in the Supplement (Table A1).

2.8. Analytic strategy

To test Hypothesis H1, we regressed parental emotional distress during the shutdown ($S_{t=1}$) on changes in work situation during the shutdown ($W_{t=1}$). As parental emotional distress and the work situation during the shutdown might be influenced by parenting stress prior to the shutdown ($S^*_{t=0}$), socio-demographics such as the mother's education, financial resources, single parenthood (X), and child's skills prior to the pandemic ($Y^*_{t=0}$), we added these characteristics as controls. Furthermore, all regression models controlled for federal state (Z).

$$S_{t=1} = \alpha + W_{t=1}\beta_W + S^*_{t=0}\beta_{S^*} + X\beta_S + Y^*_{t=0}\beta_{Y^*} + Z_{t=0}\beta_Z + e \quad (1)$$

Time (t) before shutdown (t = 0), during shutdown (t = 1).

To test Hypothesis H2, we regressed mathematical skills ($Y_{t=2}$) measured after the shutdown on parental emotional distress during the shutdown ($S_{t=1}$). As parents may have already experienced different levels of stress before any measures to curb the spread of COVID-19 were put in place, we controlled for parenting stress prior to the shutdown ($S^*_{t=0}$). In addition, we controlled for the mother's education, financial resources, and further family characteristics (X). In order to reduce the variance in test results for mathematical skills in 2020 that was due to pre-shutdown influences, we used a wide range of previously measured skills as controls ($Y^*_{t=0}$): i.e., test performance in mathematics from 2018, reasoning from 2018, and vocabulary from 2019 as well as parents' assessments of children's mathematical skills and school-related autonomy (both from 2019). Note that there was no direct measure of mathematical skills at the onset of the pandemic. In all models, federal state (Z) is controlled for.

Addressing Hypothesis H3, we regressed mathematical skills ($Y_{t=2}$) measured after the shutdown on changes in working situation during the shutdown ($W_{t=1}$) and then added parental emotional distress ($S_{t=1}$), using the same controls as before. The final model was specified as follows:

$$Y_{t=2} = \alpha + S_{t=1}\beta_S + W_{t=1}\beta_S + S^*_{t=0}\beta_{S^*} + X\beta_X + Y^*_{t=0}\beta_{Y^*} + Z_{t=0}\beta_Z + e \quad (2)$$

Time (t) before (t = 0), during (t = 1), and after complete shutdown (t = 2).

In robustness checks we added information on child's home learning environment during the shutdown to Eq. 2.

To address selectivity in panel attrition, we included indicators known to drive panel continuance in Starting Cohort 1 of the NEPS in our regression models (e.g., educational attainment and employment;

Table 1
Parents' Emotional Distress During the Shutdown and Parenting Stress Prior to the Shutdown, Mathematical Skills, Children's Skills Prior to the Shutdown, and Socio-Demographic Characteristics of the Family: Descriptive Statistics.

	Before standardization and imputation						After standardization and imputation	
Variable	n	*M*	*SD*	Range	*n of items*	α	*M*	*SD*
Parents' emotional distress, 2020[a]	1511	2.76	0.75	1 – 5	9	0.85	0.00	1.00
Parenting stress, 2018	1449	-0.02	0.65	-1.06 – 2.47	5	0.68	0.00	1.01
Mathematical skills, 2020	1512	0.00	1.21	-3.64 – 4.11			0.00	1.00
Mathematical skills, 2018	1383	0.15	1.11	-3.72 – 4.03			-0.01	1.03
Reasoning, 2018	1392	6.64	2.61	0 – 12			0.00	1.03
Vocabulary skills, 2019	1379	91.70	19.74	15 –181			-0.01	1.02
Parental assessment of mathematical skills, 2019	1462	3.64	0.86	1 – 5			0.00	1.02
School-related autonomy, 2019	1436	3.32	0.59	1 – 4	3	0.77	-0.02	1.03
Age at test (months), 2020	1512	99.44	1.55	93 – 103			0.00	1.00
Education mother (years), 2020	1512	15.55	2.25	8 – 18			0.00	1.00
Household income (equalized; log.), 2020	1460	7.69	0.46	-0.96 – 9.16			0.00	1.02

Sources: https://doi.org/10.5157/NEPS:SC1:9.1.0, own calculations. *Notes:* n = 1512 for all variables after standardization and imputation; Data collected in 2018 are from the 7th, in 2019 from the 8th, in 2020 from the 9th survey wave. Abbr. n = sample size, M = mean, SD = standard deviation. [a] measured in reference to the shutdown.

Table 2
Regression Models on Parents' Emotional Distress During the Shutdown and Children's Mathematical Skills after the Shutdown (n = 1512).

	Parents' Emotional Distress During the Shutdown				Children's Mathematical Skills after the Shutdown							
	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
Variable	*B*	*SE*	*B*	*SE*	*B*	*SE*	*B*	*SE*	*B*	*SE*	*B*	*SE*
Parent's emotional distress, 2020[a]							-0.08 * *	0.02			-0.08 * *	0.02
Changes in working situation, 2020[a] (Ref: working out of home)												
Working from home	0.13	0.07	0.17 * *	0.06					-0.13 *	0.06	-0.11	0.06
Stopped working	-0.08	0.11	-0.12	0.11					-0.25 *	0.10	-0.26 * *	0.10
Already not working before the shutdown	0.07	0.09	-0.01	0.08					-0.12	0.07	-0.12	0.07
Controls												
Parenting stress, 2018			0.33 * *	0.03	-0.02	0.02	0.01	0.02	-0.01	0.02	0.01	0.02
Education mother, 2020			-0.03	0.03	0.05	0.03	0.05	0.03	0.06	0.03	0.05	0.03
Household income, 2020			-0.08 * *	0.02	0.03	0.02	0.03	0.02	0.03	0.02	0.02	0.02
Single parent, 2020			0.08	0.08	0.10	0.08	0.11	0.07	0.11	0.07	0.12	0.07
HHM under age 14, 2020 (Ref: one)												
Two			-0.02	0.06	-0.12 *	0.06	-0.12 *	0.06	-0.11	0.06	-0.11	0.06
Three or more			0.05	0.08	-0.10	0.08	-0.09	0.08	-0.07	0.09	-0.07	0.09
Other family language, W9 (Ref: German)			-0.06	0.06	-0.09	0.06	-0.10	0.06	-0.08	0.06	-0.08	0.06
Sex of child, 2020 (Ref: male)			-0.06	0.05	-0.18 * *	0.05	-0.18 * *	0.05	-0.17 * *	0.06	-0.17 * *	0.06
Age at test, 2020			-0.01	0.02	0.02	0.02	0.02	0.02	0.03	0.02	0.02	0.02
Mathematical skills, 2018			0.00	0.03	0.38 * *	0.03	0.38 * *	0.03	0.38 * *	0.03	0.38 * *	0.03
Reasoning, 2018			0.03	0.03	0.09 * *	0.02	0.09 * *	0.02	0.09 * *	0.02	0.09 * *	0.02
Vocabulary skills, 2019			-0.01	0.03	0.03	0.03	0.03	0.03	0.04	0.03	0.03	0.03
Parental assessment of mathematical skills, 2019			0.00	0.03	0.08 * *	0.03	0.08 * *	0.03	0.08 * *	0.03	0.08 * *	0.03
School-related autonomy, 2019			-0.02	0.03	0.08 * *	0.02	0.08 * *	0.02	0.08 * *	0.02	0.08 * *	0.02
Federal states	+		+		+		+		+		+	
Constant	-0.11	0.09	-0.11	0.09	-0.02	0.15	-0.03	0.15	0.06	0.14	0.05	0.14
mean R^2 (min, max)	.02 (.02,.02)		.14 (.14,.15)		.32 (.31,.33)		.33 (.32,.33)		.33 (.32,.33)		.33 (.32,.34)	

Sources: https://doi.org/10.5157/NEPS:SC1:9.1.0, own calculations. *Notes:* OLS regressions with ten multiple imputed data sets; all continuous variables were z-standardized before imputation and still very close to z-standardization after imputation. Data collected in 2018 are from the 7th, in 2019 from the 8th, in 2020 from the 9th survey wave. Abbr. B = regression coefficient, SE = robust standard error, Ref. = reference category, HHM = household member.

[a] measured in reference to the shutdown.

*$p < .05$. * *$p < .01$.

see Würbach et al., 2021; Würbach et al., 2016). We also informed the statistical software about primary sampling units and strata, resulting in corrected standard errors. The regression results were based on 10 different estimates, which were combined according to Rubin's rules (Rubin, 2004).

3. Results

We tested our hypotheses using ordinary linear regression models with stepwise inclusion of predictors (Table 2).

H1. Impact of changes in working situation on parents' emotional distress during the shutdown

In Model 1, Table 2, the regression analysis examined the relationship between parents' emotional distress and changes in their working situation during the shutdown, only controlling for the federal states in which the families resided (estimates for federal states not shown, as in all following models). None of the factor levels of changes in working situation showed significant effects. In Model 2, we added parenting stress prior to the shutdown, socio-demographic factors, and children's skills prior to the shutdown. Here, the coefficient for working from home as opposed to working somewhere else was significant at the 1% level and positive. This indicates that, all other things being equal, emotional distress was higher in parents working from home, thus supporting Hypothesis H1. In the case of the two other categories (stopped working and already not working before the shutdown), no differences in stress level were observed compared to the stress level of parents working outside of their private household. Besides changes in working situation, parenting stress prior to the shutdown and household income were related to parents' emotional distress during the shutdown. Both coefficients were also statistically significant at the 1% level. While previous stress went hand-in-hand with higher stress during the shutdown, the higher the family's income, the lower the stress levels during the shutdown reported by parents.

H2. Impact of Parental Emotional Distress During the Shutdown on Mathematical Skills after the Shutdown

In Model 3, Table 2, we regressed the child's mathematical skills after the shutdown on all controls, i.e., on parenting stress prior to the shutdown, socio-demographic factors, the child's skills prior to the shutdown, and the federal states. Statistically significant negative coefficients were estimated for two vs. one household member under the age of 14 and for the female sex of the child. Further statistically significant coefficients were estimated for mathematical skills, parental assessment of mathematical skills, reasoning, and school-related autonomy prior to the shutdown. All of them were positively correlated with mathematical skills after the shutdown. We set Model 3 as our base model and gradually added predictors to examine our further hypotheses. In Model 4 we added parent's emotional distress during the shutdown to the specification of the base model. The coefficient was negative and significant at the 1% level. Higher parental emotional distress during the shutdown went along with lower mathematical skills after the shutdown, which supports Hypothesis H2.

H3. Mediation of the Impact of Working from Home During the Shutdown on Mathematical Skills after the Shutdown by Parental Emotional Distress During the Shutdown

In Model 5 we included changes in the working situation in the base model, i.e., Model 3. Working from home showed a statistically significant, negative effect on mathematical skills after the shutdown. Interestingly, if the mother stopped working during the shutdown, it affected the child's mathematical skills after the shutdown even more negatively. In addition, having stopped to work had no effect on parental emotional distress during the shutdown in Model 2. Therefore, family stress processes cannot be assumed to be a mechanism of this effect.

In Model 6 we added parent's emotional distress and changes in working situation during the shutdown simultaneously. While the coefficient of parental distress did not change compared to Model 4, the coefficient of working from home decreased slightly compared to Model 5 and did not reach the conventional level of statistical significance.

To test Hypothesis H3 we conducted a mediation analysis (Fig. 1) following Baron & Kenny (1986). The results of model 5 (Table 2) showed that there was a statistically significant total effect between working from home during the shutdown and children's mathematical skills after the shutdown (path c; B= 0.13, $p < .05$). Also path a (working from home on parent's emotional distress during the shutdown; Table 2, model 2: B= 0.17, $p < .01$) and path b (parent's emotional distress during the shutdown on children's mathematical skills after the shutdown; Table 2, model 6: B= −0.08, $p < .01$) were statistically significant. When parent's emotional distress entered the relationship between working from home during the shutdown and children's mathematical skills after the shutdown, the direct effect did not reach a significant level (path c'; B= −0.11, $p > .05$). The difference between the total and the direct effect (paths c and c') was minor, but statistically significant (−0.127 to −0.113; $\Delta = 0.014$, s.e = 0.006, $z = 2.403$; calculation of standard errors based on seemingly unrelated estimations (SUEST), see Mize et al. (2019)). Additionally, the Sobel test (Sobel, 1982) demonstrated that the indirect effect (path a^*b) was significant at the 95% level (B a^*b= −0.014, s.e.= 0.006, $z = 2.34$). This supports Hypothesis H3.

To further check the robustness of our findings and to shed more light on the processes and interplays in families during the shutdown impacting children's cognitive development, we took the *home learning environment during the shutdown* into account for additional analyses (Table A4 in the Supplement). Support with schoolwork as well as a quiet place for learning were negatively associated with parental emotional distress (Model 2, Table A4 in the Supplement). Whereas a quiet place for learning does not correlate with child's development of mathematical skills (see Models 3 to 6, Table A4 in the Supplement), support with schoolwork was positively associated with the development (Model 4, Table A4 in the Supplement), but only when parents' emotional distress and working conditions were not considered (Model 6, Table A4 in the Supplement). Following Baron & Kenny (1986), this refutes a possible mediating role of support with schoolwork for the effect of parental emotional distress on skill development. The effects of working from home on parental emotional distress and from emotional distress on child's skill development remained significant, even when both indicators of *home learning environment* were taken into account (Models 2 and 6, Table A4 in the Supplement). Additionally, the indirect path from working at home to child's skill development over parent's emotional distress remained significant (Models 2 and 6, Table A4 in the Supplement; Sobel: B a^*b= −0.012, s.e.= 0.005, $z = 2.19$). This supports the robustness of the mediating effect.

4. Discussion

Previous studies that applied the Family Stress Framework in the context of the COVID-19 pandemic focus mainly on socio-emotional outcomes. As we know from psychological and neuropsychological research, parental psychological distress also has adverse effects on a child's cognitive development. Research on parental stress often focusses on material deprivation or negative financial events as triggers. In the context of the COVID-19 shutdown in Germany, however, income losses were largely cushioned by federal programs. The changes much more frequently concerned parents' working conditions. The importance of changes in parental working conditions as potential triggers of stress-related processes have received little attention so far.

Our study focused on investigating the impact of parental emotional distress on the cognitive skill development of primary school students in the period of the first COVID-19 shutdown. We assumed that parental emotional distress during the shutdown was influenced by changes in parents' working situation. In particular, we expected working at home

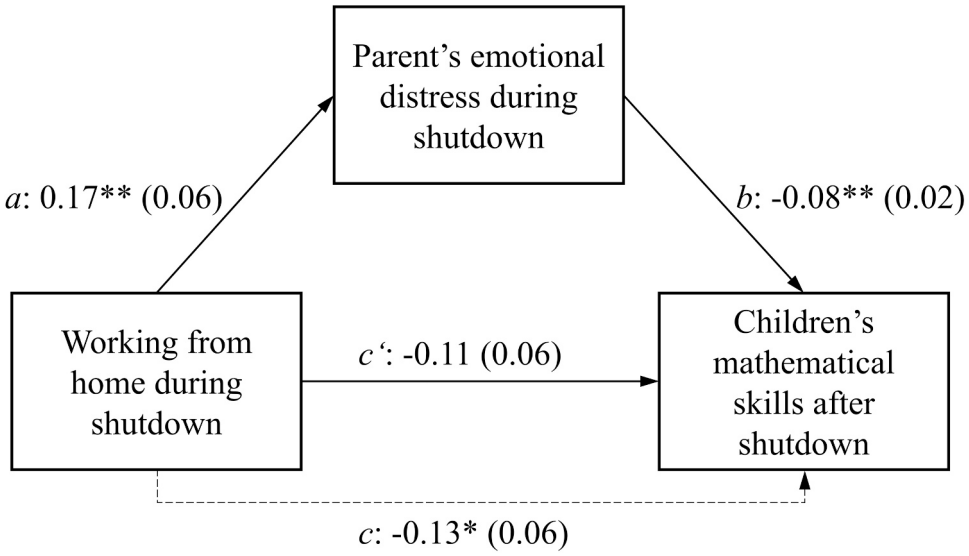

Fig. 1. Mediation Model of Working from Home During the Shutdown on Children's Mathematical Skills after Shutdown over Parent's Emotional Distress During Shutdown (n = 1512). *Notes:* based on models 2, 5, and 6, Table 2; unstandardized regression coefficients with standard errors in brackets; all continuous variables were z-standardized before imputation and still very close to z-standardization after imputation. * $p < .05$. * * $p < .01$.

to increase parental emotional distress, as parents were overburdened with simultaneously working, caring for children, and supporting them with distant learning. We hypothesized that parental emotional distress and working from home slowed down children's cognitive skill development and that the effect of working from home was mediated by heightened emotional distress of parents.

We found a positive effect of working from home on parents' emotional distress as well as a negative effect on children's mathematical skill development. Further, parents' emotional distress showed a negative effect on skill development. This effect proofed to be robust, even when the home learning environment during the shutdown was controlled for. The negative effect of working from home on skill development was partly mediated by increased parental emotional distress.

The effect of parental emotional distress on children's skill development is in line with findings reported in the literature on the Family Stress Model, as the approach originates from research on disruptive historic events and emphasizes the role of mental burden in family interactions and children's development in times of dynamic structural change and economic uncertainty (Conger et al., 1992; Elder, 1974). Can we assume that the estimated effect of − 0.08 is relevant (see Table 2)? As all predictors and outcomes are standardized before the analysis, one standard deviation more in stress is associated with a 0.08 standard deviation lower skill score. According to Passaretta & Skopek (2021, p. 1034), mathematics skills increase by about 0.12 standard deviation per month during schooling in Grade 1. This finding is based on data collected by the German NEPS in early and late spring 2013. If this monthly increase also applied to Grade 2, one or two standard deviations more in parental emotional distress would be equivalent to a learning loss of (1 SD * −0.08/(0.12 SD/month)=)−0.$\bar{6}$ or (2 SD * −0.08/(0.12 SD/month) =) −1.$\bar{3}$ months, which equals to almost 3 or 6 weeks (assuming a month lasts 30 days). According to Brunner et al. (2023, p. 10) the yearly increase in mathematical skills from grade 2 to 3 is 1.04 average standard deviation in Germany. Using this benchmark, the loss would be (1 SD *−0.08/(1.04 SD/12 month)≈) − 0.92 or (2 SD*−0.08/(1.04 SD/12 month)≈) − 1.85 months, which equals to about 4 or 8 weeks. These differences are remarkable.

As the FSM usually focusses on financial dynamics as causes for family stress, the mediation of the effect of working from home on skill development by parental distress can be seen as an extension. Our results suggest that changes in working situations triggered family stress processes during the shutdown. This especially holds true for Germany, where income losses during the shutdown were cushioned by federal support programs. Our results did not confirm the expectations expressed at the beginning of the pandemic regarding growing social inequalities in skills development. However, it should be noted that the analyses only took into account a short period of time at the beginning of the pandemic. A widening of the social divide that may have developed later in the pandemic could not be reflected in this way. In addition to the effects of factors directly related to the shutdown, gender-specific effects in the development of mathematics skills were also observed.

Interestingly, we found that parents stopping working during the shutdown had an even stronger negative association with children's skill development than parents working at home. Job loss, a negative financial event, is regularly considered to be a trigger of family stress processes (Masarik & Conger, 2017). Nevertheless, stopping work during the shutdown did not have a positive effect on parental emotional distress in our study.[2]

4.1. Strengths and limitations

The current study has many strengths, including the use of nationwide survey data based on a randomly drawn sample. A unique feature of our data is that they allow standardized test data on mathematical skills before and after the shutdown to be combined with extensive data on socio-demographic factors and information on mental health, also collected before and during the shutdown. This provides the opportunity to investigate mechanisms generating inequality in families during the COVID-19 shutdown.

Nevertheless, our research also has some limitations. First, we did not have mathematical test data collected immediately before the

[2] Approaches to causal explanations of this association have to remain speculative. The professional groups that were most likely to stop working during the shutdown were those with close interpersonal contact and sales services. Beyond lower education levels and restricted income (see Supplement, Table A2), these groups might have faced circumstances that were adverse to children's skill development. Alternatively, children might have been distracted or stressed by the presence of their parents, who had far more time at hand, leading to problems with learning. As we know from research on parental help with homework, parents' time investment in homework support can have detrimental effects, if the help is intrusive (Moroni et al., 2015).

shutdown. Therefore, the variance in the mathematical test after the shutdown might be partly due to influences prior to the shutdown, even when controlling for previous skills. Further, the operationalization of parent's stress during and before the shutdown differed. Consequently, we cannot claim to have strictly deployed the same method longitudinally; nonetheless, we followed a longitudinal perspective.

The causal interpretations of the relationships between parents' stress during and children's skills after the shutdown can be questioned. One could argue that difficulties in parental support and children's learning during the shutdown could also lead to increased stress for the parents and adverse effects on child's skill development. Actually, parents' support with schoolwork showed negative associations with emotional distress and child's skill development, however, parental support did not explain the effect of parents' emotional distress on child's skill development. Further, the children of parents working from home during the pandemic did not show any disadvantages in skills prior to the shutdown. Thus, lower skills should not have been a driver of working from home to support the child with learning (see Supplement, Table A2). In addition, children's learning problems should not have had a similar leverage on the decision to work from home than job characteristics. These arguments support our interpretation of the mediating effect. However, we cannot rule out intervening effects of unobserved variables. As there is no data on stress levels of further parents, their support or the support provided by schools, there could still be confounding effects.

Finally, in more than 97% of cases, the mother was the respondent, so no insights into the impact of the co-residents father's emotional distress can be derived from our results. In addition, the family concept used here is very narrow (see introduction). Therefore, we cannot take into account information on not co-residing parents or other family members and their engagement and relationship to the child.

4.2. Conclusion and outlook

Summing up, our study emphasizes the role of parental emotional distress in children's development during historic events like the COVID-19 pandemic. Teachers and practitioners are recommended to increase contact with families during and after phases of school closure and to be alert for signs of mental overload in parents. During crisis events, such as pandemics and natural disasters, which shift more responsibility for children's education to parents, parental stress and the resulting disturbances in family interactions appear to mediate the detrimental effect of the crisis itself. If parents are suspected to suffer from mental health issues, connecting them to local support networks and counseling may help prevent the emergence of learning gaps in children.

Expanding on the classical assumptions of the FSM, structural changes beyond financial aspects were relevant for the emergence of stress during the COVID-19 shutdown. As changes in parental working situations happening concurrently with comprehensive school closings not only seem to affect parents' well-being but also children's skill development, such effects should be taken into account when government bodies consider implementing mitigating measures. As Daumiller et al. (2023, p. 7) pointed out, it is important to "conduct tailored benefit and risk assessments specific to the socio-economic environment, healthcare system, and educational resources in the area" when considering the closing of schools as reaction to a crisis.

Our results corroborate the idea that parental stress was a crucial factor in learning processes at home during the pandemic. The cause of the disparities in parental stress during the shutdown, however, is still not fully understood. Other aspects that require further research are the long-term effects of emotional distress during the pandemic on children's skill development. In particular, the role of psychological distress during subsequent school shutdowns and potential changes in psychological stress are of major interest. In addition, cross-national studies are needed to see whether the relationship between psychological distress and child development is relatively stable across countries or whether it is moderated by the impact of country-specific regulations during school shutdowns or labor market policies designed to cushion the impact of the pandemic. As life-course research has provided compelling evidence that the impact of historic crises on child development depends on the child's age (Elder & Cox, 2019), future research should study the impact of family stress during the COVID-19 crisis on students at different stages in the education system.

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CRediT authorship contribution statement

Thorsten Schneider: Conceptualization, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision, Validation, Writing – original draft, Writing – review & editing. **Markus Vogelbacher:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Resources, Software, Validation, Visualization, Writing – original draft, Writing – review & editing.

Declaration of Competing Interest

None.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.alcr.2024.100609.

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