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ORIGINAL PAPER

COVID-19, Family Dynamics, and Perceived Mental Health Among Families in Singapore

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Abstract

The COVID-19 pandemic presents a significant challenge to the well-being of families with children. Although previous studies have documented COVID-related deterioration in parents' mental health, the underlying mechanisms remain unclear. It is also unclear how much of the deterioration is due to the pandemic itself, versus mandated lockdown measures. We conducted a cross-sectional study in Singapore to examine perceived changes in parents' lives and mental health related to the pandemic and lockdown measures. In June 2020, when Singapore had just exited a nationwide lockdown, we asked families to retrospectively report on the family dynamics, daily activities, and mental health of family members during the phases before local transmission (Pre-pandemic), during local transmission but before the lockdown (Pre-lockdown), and during the lockdown (Lockdown). Results from 180 mothers and 166 fathers from 198 families showed significant changes in jobs and income, childcare arrangements, family dynamics, and parents' perceived mental health across the three timepoints. Mothers' increased time spent on housework was associated with the increase in their mental health problems from Pre-lockdown to Lockdown. Parents' increased conflict with other adults in the household was associated with the increase in their mental health problems from Pre-pandemic to Pre-lockdown, and from Pre-lockdown to Lockdown. Mental health problems increased more for young mothers, parents with a graduate or professional degree, and fathers high on authoritarian values. Findings suggest that both the pandemic and the imposed lockdown measures impact parents' lives and family dynamics, in turn leading to deterioration in parents' mental health.

Keywords COVID-19 · Mental health · Family dynamics · Authoritarian values · Singapore

Highlights

- There were significant changes in Singaporean parents' daily activities, family dynamics, and mental health during the COVID-19 period.
- Rule setting and conflict with children increased among authoritarian fathers, and autonomy granting decreased among authoritarian mothers.
- Mothers' time spent on housework was associated with their increased mental health problems during lockdown.
- Parents' conflict with other adults in the household was associated with their increased mental health problems during both pandemic and lockdown.
- Mental health problems increased more for young mothers, parents with a graduate or professional degree, and authoritarian fathers.

The COVID-19 pandemic presents a significant challenge to the well-being of people around the world, especially for families with children. Previous studies have documented wide-spread deterioration of mental health in parents during COVID-19 (Patrick et al. 2020), yet it is still unclear whether changes in daily activities and family dynamics contributed to such deterioration. It is also unclear to what extent were the changes due to the families' responses to the

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pandemic itself or to lockdown measures imposed by the authorities. Answers to these questions have important implications for researchers and policymakers around the world when weighing the advantages and disadvantages of different infection control policies, as well as determining what to focus on for programs aiming at supporting families. Using Singapore as an example, we investigated these questions by asking families to retrospectively report their daily activities, stressors, and mental health before and during COVID-19. By comparing their experiences across different phases from pre-pandemic to a nationwide lockdown, we hope to shed light on how parents' mental health may be affected by COVID-related changes in their daily activities and family dynamics during these periods.

COVID-19 Affects Mental Health for Families with Children

The COVID-19 pandemic poses a major challenge for people's mental health. A survey by Ipsos MORI, a market research company based in the United Kingdom (UK), indicated that social and psychological problems brought on by the pandemic ranked higher as a concern to people than the prospect of contracting COVID-19. These problems included increased anxiety and depression, a lack of social contact and loneliness, as well as negative feelings related to practical aspects like finance and employment (Ipsos MORI 2020). A systematic review of studies conducted in China, Spain, Italy, Iran, the United States (US), Turkey, Nepal, and Denmark showed that people reported high rates of symptoms of anxiety, depression, post-traumatic stress disorder, stress, and psychological distress during the COVID-19 pandemic (Xiong et al. 2020).

The impact of COVID-19 on mental health is particularly noteworthy for families with children, especially with work and school shifting to being home-based (Fontanesi et al. 2020). Surveys in the US showed that almost all families reported significant disruptions to their daily lives and routines due to school and business closures, and 35% of parents who continued to work during the pandemic reported having difficulties in handling childcare responsibilities (Pew Research Center 2020). Twenty-four percent of parents reported a loss of regular childcare, and the majority of parents reported that their child needed to be watched by a parent (Patrick et al. 2020). These stressors brought significant challenges to parents' mental health, with 27% of US parents reporting worsening mental health (Patrick et al. 2020). Surveys from Singapore also suggested that there was a significant increase in people's anxiety levels due to COVID-19, and that those who had children under 18 tended to worry more than those who did not (Awang 2020; Chung et al. 2022).

Some individuals' mental health was more severely impacted by COVID-19 than others. In Xiong et al. (2020) review of studies on the impact of COVID-19 on mental health, the risk factors identified included: female gender, younger age group, chronic/psychiatric illnesses, unemployment, student status, and exposure to media about COVID-19. Studies focusing on families showed that a higher proportion of parents with younger children reported declines in their mental health compared to parents with older children (Patrick et al. 2020; Wu et al. 2020). Female and unmarried parents reported higher rates of worsening mental health (Patrick et al. 2020). In the US, parents who perceived more support from others experienced lower stress (Brown et al. 2020). Additionally, the greater quarantine-related difficulties Italian parents perceived (e.g., difficulties in finding relaxing spaces or time), the more their well-being was undermined (Spinelli et al. 2020). A survey on Chinese parents showed that their mental health and well-being during the pandemic were affected by perceived stress, marital satisfaction, social support, family conflict, parents' history of mental illness, and parenting styles. In particular, authoritative parents reported lower levels of depression than authoritarian parents; parents experiencing family conflict reported significantly higher levels of depression, anxiety and stress than parents with a harmonious family (Wu et al. 2020).

Though much research has documented the impact of COVID-19 on parents' mental health and identified potential protective and risk factors, the mechanisms underlying such impact remain unclear. According to the Family Stress Model (Conger and Elder 1994; Masarik and Conger 2017), contextual risk often "gets inside the family" by changing the interpersonal relationships within the family. Therefore, to understand COVID-related changes in family members' well-being, it is important to first examine how family dynamics and interpersonal relationships have been altered during the pandemic, which requires data on the family level in addition to the individual level. Another important distinction yet to be explored is whether families *chose* to change their lifestyles when facing the threat of coronavirus, or whether they were *forced* to make changes because of infection control measures imposed on them. This raises the question of whether voluntary and enforced measures impacted mental health differently. Empirical evidence on these issues is important for policymakers when they weigh the benefit of lockdown measures on curtailing transmission against potential social, psychological, and financial burdens on families. Such evidence could also be used to identify what family demanded most during the pandemic and lockdown (e.g., financial support, childcare, or family counselling), in order to help direct relief resources to where they are most needed.

The Case of Singapore

Singapore provides a unique opportunity to examine the mechanisms underlying the COVID-19 pandemic's impact on family life and well-being. First, the island nation experienced a relatively well-defined period of pandemic and lockdown, when policies like school closures and gathering bans were consistently applied nationwide. This allowed us to find a large sample of families who faced similar challenges at the same time, so that the differences found between families were less likely to be confounded by varied conditions and policies in their local communities. Second, Singapore underwent a prolonged period when there was persistent local transmission and heightened awareness to the threat of the coronavirus, yet the government imposed minimal mandatory restrictions on people's everyday lives (February–March 2020). Contrasting this period with the "circuit breaker" period that followed, when extensive lockdown measures were enforced (April–May 2020), can help separate the effects of voluntary versus imposed measures on mental health.

Figure S1 shows the timeline of the COVID-19 pandemic in Singapore in 2020. The first imported COVID-19 case was confirmed on January 23, 2020, and local transmission was first reported on February 3. Throughout February and early March, the number of new cases remained low, until a sharp increase in imported cases occurred in late March. In response to the fast-increasing number of new and unlinked cases, the Singapore government carried out a stringent set of lockdown measures from April 7 to June 1, officially known as the "circuit breaker". As a result, local cases decreased starting from late April.

Comparing the period of local transmission before the "circuit breaker" (February 4–April 6) and the "circuit breaker" period (April 7–June 1), the number of new local cases (imported cases plus cases in the community) did not differ significantly. On average there were 18.9 new cases daily (SD = 21.0) during local transmission prior to the "circuit breaker", and there were 23.7 new cases daily (SD = 21.5) during the "circuit breaker", $t(117) = 1.24$, $p > 0.2$ (Ministry of Health Singapore 2020). There was also a large number of cases in foreign workers' dormitories druing the "circuit breaker", although most cases were mild and the dormitories were largely isolated from the rest of Singapore. The main contrast was in lockdown measures (Fig. S1): Before the "circuit breaker", Singapore government's infection control endeavors focused on border control and contact tracing, and the measures that applied to the general public were mainly precautionary, such as social distancing, hand washing, and wearing of masks if unwell. This is in sharp contrast with a full-scale lockdown in April and May, when all schools, non-essential workplaces, and places of entertainment and worship were closed, and all residents were strongly encouraged to stay at home (Gov.sg 2020). In sum, though the threat of the virus was acute both before and during the "circuit breaker", the restrictions forced upon families were significantly more extensive in the latter period.

The Present Study

Taking advantage of the naturally occurring contrast between these different periods, we aimed to use Singapore as an example to examine how the pandemic and lockdown changed parents' daily activities and well-being. In addition, guided by the Family Stress Model (Masarik and Conger 2017), we examined whether family-level changes such as household composition, childcare arrangement, and family dynamics, are associated with changes in parents' mental health. Potential risk and protective factors, such as family demographics and parenting values (Wu et al. 2020), were also examined. Based on the Family Stress Model, we test the following hypotheses in the present study:

1. Family dynamics and daily activities change for parents during the pandemic and lockdown.
2. These changes are associated with changes in parents' mental health during the COVID pandemic and lockdown.
3. How parents' mental health change during the COVID pandemic and lockdown is further moderated by demographic factors and parenting values.

To address these questions, we collected parents' retrospective self-reports on their daily activities and mental health at three timepoints: Pre-pandemic (before local transmission), Pre-lockdown (during local transmission but before the "circuit breaker"), and Lockdown (during the "circuit breaker"). By comparing their responses between Pre-lockdown and Pre-pandemic, we estimate the changes associated with the pandemic itself. By comparing their responses between Lockdown and Pre-lockdown, we estimate the additional changes associated with imposed lockdown measures. To minimize recollection errors, we completed data collection within 1 month after the lockdown. We also asked participants to think about a concrete timepoint (e.g., January 2020), and to report objective events (e.g., daily activities) before reporting mental health, so that their report of past mental health can be situated in a more concrete context.

Method

We designed a survey to distribute to families who had at least one child under the age of 18 living in their household during the COVID-19 period. The survey was sent as a part

of a larger package of surveys. The whole package was approved by the [masked for blind review] Institutional Review Board and was distributed through email lists and social media. Each family filled out one package after signing a consent form and received a voucher worth SGD $10 afterwards.

Participants

Complete responses were collected from 198 families residing in Singapore. An additional 25 responses were excluded because they were either incomplete, or failed a basic quality check (e.g., indicated <21 h of sleep per week for a prolonged period suggesting that participants were not carefully reading/responding to the questionnaire). Our sample comprised 180 mothers and 166 fathers in these 198 families, who took care of 234 children under 18 years of age. As part of the larger project, data was also collected from 159 other adults living in the same households (grandparents, full-time domestic helpers, adult siblings, and other relatives). This data were included when calculating family-level variables (e.g., number of adults, monthly household income), but was not analyzed further as the focus of this study is on parents. Table S1 lists the demographic information of the sample in comparison with the Singapore population. Median monthly household income for the sample in January 2020 (SGD$6500) was significantly lower than the 2019 national median (SGD $7981), $\chi^2(1) = 10.3$, $p = 0.001$.

Instruments

The survey was constructed using Qualtrics survey software and comprised questions about the overall family, as well as each adult in the family. Respondents who filled out the survey were asked to consult their family members on questions pertaining to them, to ensure everyone's opinions were accurately represented. For measures that may change because of COVID-19 (household composition, jobs and income, daily activities, family dynamics, mental health, and stressors), we asked participants to report answers regarding three defined timepoints: Pre-pandemic (January 2020), Pre-lockdown (February–March 2020), and Lockdown (April–May 2020). Respondents who experienced unusual events during January 2020 were asked to use a different month as a pre-pandemic baseline. All data were collected in June 2020. We consistently used a 11-point scale (0–10) for all Likert items because it has superior psychometric properties and normality compared to scales with fewer points (Leung 2011), and is also easy to comprehend. The full survey is listed in the Supplementary Material.

Background information

Families reported demographic information including citizenship, ethnicity, language spoken at home, and type of housing. They also reported the number of adults and children living in the household at each of the three timepoints, as well as whether anyone in the family had been diagnosed with COVID-19 or received a Quarantine Order (QO), a Leave of Absence notice (LOA), or a Stay-Home Notice (SHN). Each adult in the family reported basic information including gender, age, relationship to the children in the household, education level, and existing disabilities or mental health conditions. They also reported their job situation and monthly income for each timepoint.

Daily activities

Parents reported time spent on typical adult responsibilities such as work, housework, and childcare, as well as activities which might be affected by COVID such as socializing and exercising (see Supplementary Material for a complete list). We asked parents to report how many hours they engaged in each of these activities every week, the responses were then divided by seven to get the number of hours per day, averaged across weekdays and weekends.

Family dynamics

Family dynamics were measured by a set of frequency measures (0: never, 10: always) on how parents interacted with other family members living in the same household, including rule setting (setting up rules for children to follow without explaining why), autonomy granting (allowing children to make decisions for themselves), conflict with children, and conflict with adults.

Parenting values

Parents reported their parenting values with the Child-rearing Values Questionnaire (Feldman and Stenner 1997; Tagar et al. 2014). This questionnaire focuses on how much parents endorse authoritarian values—the belief that for children, submitting to established authorities and social convention is more important than maintaining their autonomy. Previous research has shown that parental authoritarianism influences both parent-child interaction (Mills et al. 2022) and parental mental health (Wu et al. 2020). In this study, parents were asked to choose the quality they thought was more important for a child to possess (out of a pair): respect for elders or independence, curiosity or good manners, obedience or self-reliance, being considerate or being well-behaved. An authoritarianism

score (0–4) was calculated based on the number of times "respect for elders", "good manners", "obedience", and "being well-behaved" were chosen. In our sample this questionnaire has good internal reliability, McDonald's $\omega = 0.79$.

Mental health and stressors

Mental health was measured by the Patient Health Questionnaire-4 (PHQ-4, Kroenke et al. 2009). It included two questions on anxiety, and two questions on depression. Previous studies revealed good internal reliability for the questionnaire, Cronbach's $\alpha > 0.80$, and it correlated strongly with the mental health subscale of the longer SF-20 (Stewart et al. 1988), $r = 0.80$. We used a 11-point Likert scale (0: never, 10: always) instead of the original 4 point scale to increase sensitivity in our non-patient sample (Leung 2011). Higher scores indicated more mental health problems. In our sample this questionnaire has good internal reliability, McDonald's $\omega = 0.84$.

Parents also reported the levels of stress they experienced from daily activities, as well as from COVID-19-related stressors such as health concerns, concerns about jobs and finances, inconveniences in working or getting necessities, and reading negative news (see Supplementary Material for a complete list).

Data Analysis

All data were entered and analyzed in Excel, IBM SPSS 22, R 4.0.3, and Mplus 8.8 (IBM Corp. 2013; Muthén and Muthén 2017; R Core Team 2020). Given the multilevel structure of our sample (timepoints were nested under individuals, and individuals were nested under families), we used multilevel mixed-effects linear regression models as the analytical tool for the omnibus tests. Timepoint was treated as an independent variable with fixed effects. It was dummy coded with Pre-lockdown as the reference group, so that the *B* coefficients reflected the differences between Pre-pandemic and Pre-lockdown, and between Pre-lockdown and Lockdown. Interaction effects were tested by including timepoint × predictor as fixed-effect variables, and significant results were further examined by simple effect tests which assessed differences across timepoints within each level of the predictor. All mixed models were implemented using the lme4 package in R. All models were fitted using the maximum likelihood (ML) estimation to facilitate model comparisons. Significance tests for the unstandardized coefficients (*B*s) were performed with the lmerTest package, with an α level of 0.05 (two-tailed). Mediation analyses were performed with the Bayesian multilevel mediation model, which is suitable for multilevel data with a within-subject design (Vuorre and Bolger 2018). We used the bmlm package in R to bootstrap 10,000 samples to calculate the distributions of the parameters. Sobel's test was also conducted to verify significant mediation effects (Sobel 1982). Because the mediation analyses were exploratory in nature, we used a more stringent α level of 0.001 (two-tailed) to correct for multiple comparisons.

Results

None of the participating families had any family members who were diagnosed with COVID-19. Seven adults and six children from five families had received either a QO, an LOA, or a SHN because of international travel or close contact with confirmed cases. Their perceived mental health did not differ significantly from their peers, $-0.9 < ts < 0.4$, $ps > 0.4$ for all timepoints for both adults and children.

Changes in Household Composition

COVID-19 had little impact on the composition of household in our sample. Between January and May 2020, two families observed a change in children living in the household because of babies being born, and four families experienced a change in adults because of long-term pass holders (foreigners working in Singapore) not being able to renew their passes, or adult children or relatives moving out.

Changes in Jobs and Income

As shown in Fig. S2, the most significant trend regarding parents' jobs was that 50% of full-time employees who rarely worked from home before the pandemic switched to mostly working from home during lockdown. In addition, the number of parents who worked as a full-time employee decreased significantly from Pre-pandemic (233 out of 346) to Lockdown (202), Fisher's exact $p = 0.018$.

On average, monthly household income decreased 7% from Pre-pandemic to Lockdown, and 17% of the families suffered an income decrease of more than 30%. A mixed-effect model with family as a random-effect variable showed a significant fixed effect of timepoint, $\chi^2\,(2) = 66.1$, $p < 0.001$. Average household income did not change significantly between Pre-pandemic and Pre-lockdown, $B = -145$, 95% confidence interval (CI) = [−473, 182], but it decreased significantly from Pre-lockdown to Lockdown, $B = -575$, CI = [−903, −247].

Changes in Childcare Arrangement

Before the pandemic, 29% of infants (0–2 y) attended daycare, 87% of preschoolers (3–6 y) attended daycare or

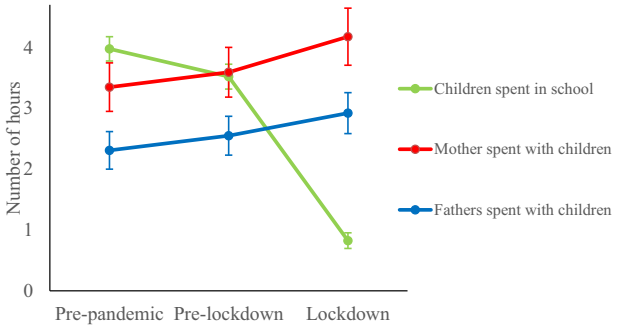


Fig. 1 Number of Hours per Day Parents Spent with Children During the COVID-19 Period. The number of hours were averaged across weekdays and weekends. They were reported by parents, and included hours spent with all children in the household. Error bars denote standard error

kindergarten (one additional 6-year-old attended primary school), and 90% of school-aged children and adolescents (7–18 y) attended primary school, secondary school, or post-secondary institution. A mixed model with child and family as random-effect variables showed that the number of hours children spent in daycare and school (including school-based student care) decreased from Pre-pandemic to Pre-lockdown, $B = -0.46$, CI = [−0.80, −0.11], and decreased further from Pre-lockdown to Lockdown, $B = -2.70$, CI = [−3.04, −2.35].

As shown in Fig. 1, time spent with children changed significantly during the pandemic and lockdown for both parents, χ^2s > 16, $p < 0.001$, and the increase was significant both from Pre-pandemic to Pre-lockdown (mothers: $B = 0.245$, CI = [0.002, 0.487]; fathers: $B = 0.241$, CI = [0.055, 0.427]) and from Pre-lockdown to Lockdown (mothers: $B = 0.584$, CI = [0.341, 0.827]; fathers, $B = 0.371$, CI = [0.185, 0.557]). Compared to Pre-pandemic, during Pre-lockdown mothers spent more time playing with children, and fathers spent more time meeting children's basic needs (Table 1). It should be noted that fathers still spent significantly less time meeting children's basic needs (on average 0.86 h per day) than mothers (1.38 h) during Pre-lockdown, $B = -0.521$, CI = [0.253, 0.790]. Compared to Pre-lockdown, both parents spent more time meeting children's basic needs during Lockdown, as well as tutoring their homework or home-based learning, and playing with them (*p*s < 0.05).

Changes in Family Dynamics

Next, we looked at family dynamics, including the frequencies of parents' rule setting, autonomy granting, conflict with children, and conflict with adults. Because parenting style plays an important role in family dynamics and functioning (Wu et al. 2020), we included parental authoritarian values in the analysis. Results showed that overall, fathers held more authoritarian values than mothers, $B = 0.036$, CI = [0.012, 0.060]. On the other hand, mothers were more likely to set rules for children than fathers, $B = 0.319$, CI = [0.034, 0.603]; and reported more conflict with both children, $B = 0.429$, CI = [0.110, 0.747], and adults in the household, $B = 0.326$, CI = [0.040, 0.611]. Autonomy granting did not differ between mothers and fathers, $B = -0.171$, CI = [−0.457, 0.114].

We then examined how family dynamics changed during the COVID-19 period by running mixed-effect models with timepoint, authoritarianism, and authoritarianism × timepoint as fixed-effect variables. Significant effects of timepoint were found for six out of eight models, and significant authoritarianism × timepoint interactions for three models (Table 2). Compared to Pre-pandemic, during Pre-lockdown both mothers and fathers set more rules for their children to follow without explanation and experienced more conflict with both children and adults in the family, *p*s < 0.001. These tendencies increased further during Lockdown, *p*s < 0.001. To further investigate the interaction effects, we compared parents who scored high on authoritarianism (>2, 79 mothers and 76 fathers) with those who scored low (<2, 43 mothers and 35 fathers). Those who scored in the middle (=2, 58 mothers and 55 fathers) were omitted from the analysis.

The first significant interaction effect was observed in fathers' rule setting, χ^2 (2) = 7.6, $p = 0.02$ (Fig. 2a). Frequency of rule setting did not change across timepoints for low authoritarian fathers, χ^2 (2) = 1.0, $p = 0.60$, but it increased significantly from Pre-lockdown to Lockdown for high authoritarian fathers, $B = 0.493$, CI = [0.118, 0.869]. The second significant interaction effect was observed in mothers' autonomy granting, χ^2 (2) = 9.8, $p = 0.007$ (Fig. 1b). Frequency of autonomy granting did not change across timepoints for low authoritarian mothers, χ^2 (2) = 2.6, $p = 0.28$, but it decreased significantly from Pre-pandemic to Pre-lockdown for high authoritarian mothers, $B = -0.253$, CI = [−0.501, −0.005]. The third significant interaction effect was observed in fathers' conflict with children, χ^2 (2) = 7.7, $p = 0.02$ (Fig. 1c). Frequency of conflict with children did not change across timepoints for low authoritarian fathers, χ^2 (2) = 4.9, $p = 0.09$, but increased for high authoritarian fathers, χ^2 (2) = 20.6, $p < 0.001$. The change was significant both from Pre-pandemic to Pre-lockdown, $B = 0.493$, CI = [0.175, 0.810], and from Pre-lockdown to Lockdown, $B = 0.611$, CI = [0.295, 0.927].

Changes in Parents' Mental Health

To examine the changes in parents' perceived mental health (measured by the average score of PHQ-4), we ran mixed models with timepoint, gender, and gender × timepoint as

Table 1 Changes in time parents spent with children during the COVID-19 period

	Mothers		Fathers	
	B	95% CI	*B*	95% CI
Meeting children's basic needs				
Pre-pandemic	−0.086	[−0.179, 0.008]	**−0.069**	**[−0.121, −0.017]**
Lockdown	**0.113**	**[0.019, 0.206]**	**0.084**	**[0.032, 0.136]**
Tutoring children's homework				
Pre-pandemic	−0.093	[−0.215, 0.029]	−0.067	[−0.156, 0.023]
Lockdown	**0.272**	**[0.149, 0.394]**	**0.112**	**[0.023, 0.201]**
Doing enrichment activities				
Pre-pandemic	0.015	[−0.104, 0.134]	−0.017	[−0.065, 0.032]
Lockdown	0.020	[−0.099, 0.14]	0.003	[−0.046, 0.052]
Playing with children				
Pre-pandemic	**−0.083**	**[−0.163, −0.004]**	−0.090	[−0.194, 0.014]
Lockdown	**0.175**	**[0.096, 0.254]**	**0.164**	**[0.06, 0.268]**

Bs and 95% CIs were reported from mixed-effect models with timepoint as a fixed-effect variable and individual and family as random-effect variables. Numbers in bold indicated that the coefficients are significantly different from 0 (tested using the lmerTest package in R). Pre-lockdown was set up as the reference group in the model

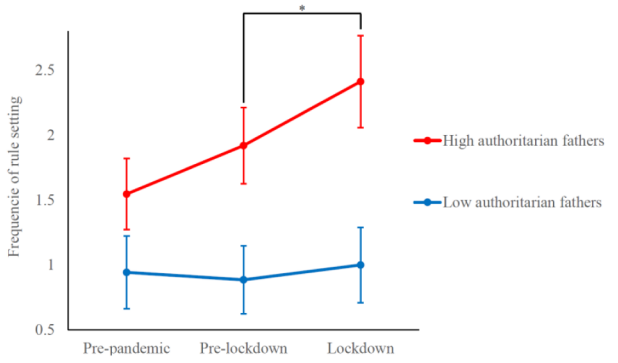
Table 2 Factors that influenced family dynamics during the covid-19 period

	Mothers			Fathers		
	χ^2	*df*	*p*	χ^2	*df*	*p*
Rule setting without explanation						
Timepoint	**32.0**	**2**	**<0.001**	**26.4**	**2**	**<0.001**
Authoritarianism	1.1	1	0.30	3.2	1	0.08
Authoritarianism × timepoint	2.1	2	0.34	**7.6**	**2**	**0.02**
Autonomy granting						
Timepoint	0.3	2	0.87	3.6	2	0.16
Authoritarianism	0.6	1	0.43	1.9	1	0.17
Authoritarianism × timepoint	**9.8**	**2**	**0.007**	0.5	2	0.76
Conflict with children						
Timepoint	**57.0**	**2**	**<0.001**	**60.6**	**2**	**<0.001**
Authoritarianism	2.6	1	0.11	2.5	1	0.11
Authoritarianism × timepoint	0.3	2	0.86	**7.7**	**2**	**0.02**
Conflict with adults						
Timepoint	**51.9**	**2**	**<0.001**	**45.7**	**2**	**<0.001**
Authoritarianism	0.9	1	0.35	2.1	1	0.15
Authoritarianism × timepoint	0.8	2	0.67	1.8	2	0.41

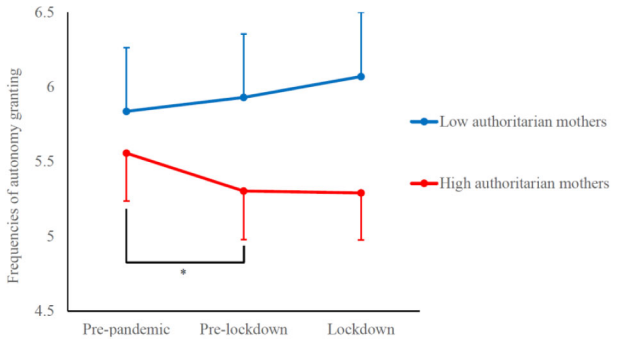
Here we report model parameters from eight mixed-effect models, including one model fitted on mothers' data and one fitted on fathers' data for each of the four measures on family dynamics. Results of χ^2 tests are reported from the analysis of deviance table of the mixed-effect models. Numbers in bold indicated that the inclusion of the fixed-effect variable significantly imporved the model fit

fixed-effect variables, and individual and family as random-effect variables. Results showed significant main effects of both timepoint, χ^2 (2) = 154.1, $p < 0.001$, and gender, χ^2 (1) = 7.5, $p = 0.006$. Parents' mental health problems increased significantly during Pre-lockdown compared to Pre-pandemic, $B = 0.356$, CI = [0.216, 0.496], and increased further during Lockdown compared to Pre-lockdown, $B = 0.299$, CI = [0.159, 0.440]. On average, mothers had more mental health problems than fathers, $B = 0.225$, CI = [0.003, 0.447]. The gender × timepoint interaction effect was not significant, χ^2 (2) = 0.5, $p = 0.77$.

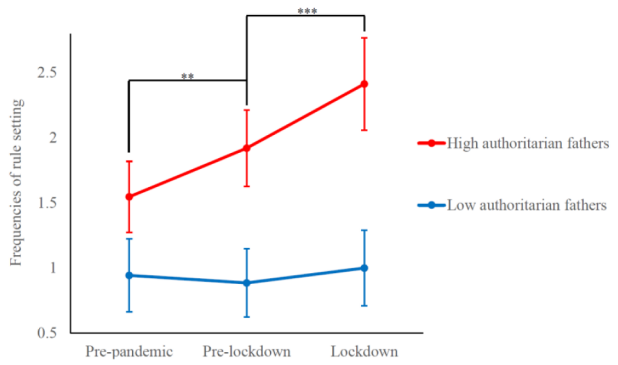
Table 3 and S2 showed parents' experiences of various stressors associated with COVID-19. The top two stressors for both mothers and fathers during Lockdown were



(a) Rule setting for high- and low-authoritarian fathers



(b) Autonomy granting for high- and low-authoritarian mothers



(c) Father-child conflict for high- and low-authoritarian fathers

Fig. 2 Frequencies of **a** rule setting, **b** autonomy granting, and **c** father–child conflict for high- and low-authoritarian parents during the COVID-19 period (0: Never; 10: Always). Error bars denote standard error. $*p < 0.05$, $**p < 0.01$, $***p < 0.001$

concerns about family members' health and safety, and concerns about own health and safety. The next three top stressors differed by gender: Mothers were stressed about caring for children, limited visiting of family/relatives, and reading about negative news. Fathers were stressed about high demand from job/business, limited travelling or going outside, and financial difficulties. The five stressors that increased the most in severity from Pre-pandemic to Lockdown were the same for mothers and fathers: limited visiting of family/relatives, limited travelling or going outside, concerns about family members' health and safety, concerns about own health and safety, and inconveniences in working/doing business.

Factors That Influenced Parents' Mental Health During COVID-19

To investigate factors influencing parents' mental health, we fitted two mixed-effect models, one for mothers' PHQ-4 score, and one for fathers' score. Individual was entered as a random-effect variable. The predictors we included in the model were demographic variables, family composition, family dynamics, jobs and income, and parents' daily activities. Previous literature suggest that these variables may be related to changes in parents' mental health. To avoid problems of multicollinearity, we did not include any predictors with a variance inflation factor (VIF) higher than 10. Two predictors in the model had a VIF > 5—timepoint (VIF = 9.7 for mothers and 9.3 for fathers) and age × timepoint (VIF = 5.9 for mothers and 5.5 for fathers), but we kept them in the model because of their theoretical importance. Excluding age × timepoint does not qualitatively change any results (Table S3). Parents' experiences of various stressors were not included as predictors because they were highly correlated with one another as well as with mental health. For predictors that were invariant across timepoints (e.g., authoritarianism), we included both the predictor itself and its interaction with timepoint as independent variables with fixed effects. For predictors that varied across timepoints (e.g., conflict with other adults in the household), we included only the predictor itself.

Results (Table 4) showed that factors influencing mothers' mental health included timepoint, age, education level × timepoint, time spent on housework, conflict with adults, and number of children × timepoint. Factors influencing fathers' mental health included timepoint, education level × timepoint, authoritarianism × timepoint, and conflict with adults. Among these factors, mothers' time spent on housework and both parents' conflict with other adults increased significantly during the COVID-19 period, χ^2s > 28, ps < 0.001, and they also predicted concurrent mental health, ps < 0.001. Therefore, we conducted mediation analyses on these two predictors.

To examine the association between changes in housework load and mothers' mental health, we fitted mothers' PHQ-4 score in the first two timepoints (Pre-pandemic and Pre-lockdown) with a mixed-effect model with pandemic and housework as fixed-effect variables, and individual as a random-effect variable. Results showed that the main effect of housework was not significant, $B = 0.077$, CI = [−0.016, 0.169], therefore the worsening of mothers' mental health during Pre-lockdown was not mediated by housework. For lockdown, mixed effect models for the last two timepoints (Pre-lockdown and

Table 3 Changes in parents' experiences of different stressors during the COVID-19 period

	Mothers		Fathers	
	Pre-pandemic	Lockdown	Pre-pandemic	Lockdown
Care for children	**−0.63*****	**0.59*****	**−0.53*****	**0.49*****
Care for elderly people	**−0.61*****	**0.50*****	**−0.53*****	**0.43****
Housework	**−0.49*****	**0.37*****	**−0.31****	**0.26****
High demands from job/business	**−0.51*****	**0.53*****	**−0.51*****	0.20
Inconveniences in working/doing business	**−1.12*****	**0.81*****	**−1.01*****	**1.06*****
Worries about losing job/business	**−0.80*****	**0.46****	**−0.97*****	**0.82*****
Financial difficulties	**−0.52*****	**0.63*****	**−0.64*****	**0.81*****
Difficulties in getting necessities	**−1.22*****	**0.45****	**−1.12*****	**0.34***
Suboptimal living conditions	**−0.41*****	**0.24***	**−0.37****	0.21
Concerns about own health and safety	**−1.32*****	**0.70*****	**−1.28*****	**0.63*****
Concerns about family members' health and safety	**−1.51*****	**0.74*****	**−1.31*****	**0.88*****
Reading about negative news	**−0.95*****	**0.63*****	**−0.91*****	**0.52*****
Limited travelling or going outside	**−1.28*****	**1.02*****	**−1.32*****	**0.91*****
Limited socialization with friends/colleagues	**−0.99*****	**0.76*****	**−1.00*****	**0.70*****
Limited visiting of family/relatives	**−1.29*****	**1.33*****	**−1.13*****	**1.25*****

Unstandardized coefficients were reported from mixed-effect models with timepoint as a fixed-effect variable and individual and family as random-effect variables. Numbers in bold indicated that the coefficients are significantly different from 0 (tested using the lmerTest package in R). Pre-lockdown was set up as the reference group in the model

$^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$

Lockdown) showed that housework predicted mental health when controlling for lockdown, $B = 0.198$, CI = [0.118, 0.278], and lockdown predicted both housework, $B = 0.364$, CI = [0.219, 0.509], and mental health $B = 0.299$, CI = [0.178, 0.421]. The effect of lockdown on mental health was reduced after controlling for housework, $B = 0.230$, CI = [0.109, 0.350], suggesting a partial mediation (Fig. 3a). The mediation effect was tested with both Sobel's test (Sobel 1982) and the bootstrapping method (Vuorre and Bolger 2018). Sobel's test turned out to be significant, $t = 3.35$, $p < 0.001$. Results from the Bayesian multilevel mediation model also indicated a significant mediation effect, $M = 0.11$, SE = 0.04, 95% credible interval = [0.06, 0.19]. Therefore, hours spent on housework was associated with the worsening of mothers' mental health from Pre-lockdown to Lockdown.

We then explored the mediating effect of parents' conflict with other adults using the same method. Three mixed-effect models were each fitted for pandemic (Fig. 3b) and lockdown (Fig. 3c), all with individual and family as random-effect variables, and all resulted in significant coefficients for the fixed-effect variables (lockdown, pandemic, and conflict). For both pandemic and lockdown, the direct effect was significant but smaller than the total effect, which suggested partial mediations. Sobel's test showed a significant mediation effect of parents' conflict with adults for both pandemic, $t = 5.18$, $p < 0.001$, and lockdown, $t = 3.90$, $p < 0.001$. The Bayesian multilevel mediation model has not been applied here because it is not suitable for three-level data. Notably, these mediation effects were also significant when mothers' and fathers' data were separated, $ps < 0.001$, indicating that conflict with adults served as a mediator for both parents.

Because both hours spent on housework and mothers' conflict with other adults mediated lockdown-related changes in mothers' mental health, we further explored a multiple mediator model to examine the relative contributions of these two mediators (Fig. S3). When considering both mediators together, only hours spent on housework significantly explained the link, IE = 0.08, CI = [0.04, 0.12], $p < 0.001$.

Next, we examined potential moderators that may expose parents to more COVID-related mental health problems. Firstly, we fitted mothers' PHQ-4 score with a mixed-effect model using timepoint, age, and age × timepoint as fixed-effect variables and individual as a random-effect variable. Results showed a significant effect of timepoint, χ^2 (2) = 102.8, $p < 0.001$, as well as a significant age × timepoint interaction, χ^2 (2) = 8.6, $p = 0.01$. When we separated the three timepoints (Fig. 4a), age was a significant predictor for mothers' mental health during Lockdown, $B = -0.038$, CI = [−0.069, −0.006], with younger mothers experiencing more mental health problems than older mothers. The age effect was not significant for Pre-pandemic, $B = -0.017$, CI = [−0.046, 0.012], or Pre-lockdown, $B = -0.027$, CI = [−0.057, 0.004].

Table 4 Factors predicting parents' mental health during the COVID-19 period

	Mothers			Fathers		
	χ^2	*df*	*p*	χ^2	*df*	*p*
Timepoint	**11.2**	**2**	**0.004**	**7.4**	**2**	**0.02**
Measurements for the parent						
Age	**3.9**	**1**	**0.047**	2.0	1	0.16
Age × timepoint	0.3	2	0.86	0.7	2	0.71
Education level	0.1	1	0.80	0.4	1	0.55
Education level × timepoint	**8.1**	**2**	**0.02**	**9.8**	**2**	**0.01**
Job flexibility	0.0	1	0.94	0.6	1	0.45
Job location	1.6	1	0.20	1.1	1	0.30
Monthly individual income	0.6	1	0.45	0.6	1	0.44
Authoritarianism	0.3	1	0.59	2.4	1	0.12
Authoritarianism × timepoint	0.2	2	0.92	**7.6**	**2**	**0.02**
Number of hours spent…						
working	0.6	1	0.42	3.6	1	0.06
doing housework	**14.4**	**1**	**<0.001**	2.9	1	0.09
with children	0.2	1	0.70	1.2	1	0.27
sleeping	0.1	1	0.76	1.5	1	0.22
Conflict with children in household	1.8	1	0.18	3.7	1	0.06
Conflict with adults in household	**54.1**	**1**	**<0.001**	**25.1**	**1**	**<0.001**
Measurements for the family						
Citizenship	4.7	2	0.10	0.1	2	0.96
Citizenship × timepoint	3.1	4	0.54	0.5	4	0.97
Ethnicity	1.6	3	0.65	3.2	3	0.36
Ethnicity × timepoint	5.4	6	0.49	5.8	6	0.45
Number of children in household	0.1	1	0.76	0.3	1	0.57
Number of children × timepoint	**6.2**	**2**	**0.046**	1.6	2	0.45
Number of adults in household	0.0	1	0.99	1.4	1	0.24
Number of adults × timepoint	4.8	2	0.09	0.2	2	0.92
Monthly household income	0.9	1	0.35	0.9	1	0.33

Numbers in boldface indicate significant results. Because job arrangements can potentially influence COVID-related stress, we developed an exploratory coding scheme in which larger numbers indicate more flexibility and higher likelihood to stay at home. Job flexibility was coded as 1 for full-time jobs; 2 for part-time jobs, self-employment, and student; and 3 for all others. Job location was coded as 1 for rarely worked from home; 2 for partially worked from home, self-employment, and student; and 3 for all others. We are aware that there may be exceptions (e.g., certain self-employment jobs can be less flexible than full-time jobs and require working away from home), but because these variables were non-significant in the model, we did not examine them further

Secondly, we looked at education level by fitting parents' PHQ-4 score with a mixed-effect model using timepoint, gender, education level, gender × timepoint, education level × timepoint, gender × education level, and gender × education level × timepoint as fix-effect variables, and individual and family as random-effect variables. Results showed a significant effect of timepoint, χ^2 (2) = 153.2, $p < 0.001$, as well as a significant education level × timepoint interaction, χ^2 (6) = 33.5, $p < 0.001$. No main or interaction effect involving gender was significant. As shown in Fig. 4b, compared to parents with a post-secondary diploma, parents with secondary diploma or lower experienced an overall higher level of mental health problems, $B = 0.487$, CI = [0.042, 0.931]. On the other hand, compared to parents with a post-secondary diploma, parents with a graduate or professional degree experienced a sharper increase in mental health problems both from Pre-pandemic to Pre-lockdown, $B = 0.338$, CI = [0.061, 0.615], and from Pre-lockdown to Lockdown, $B = 0.421$, CI = [0.145, 0.698]. These results suggested that although parents with low education levels had overall lower levels of mental health, parents with very high education levels may be more vulnerable to deterioration of mental health during the period of COVID-19.

Thirdly, we looked at the number of children in the household by fitting mothers' PHQ-4 score with a mixed-effect

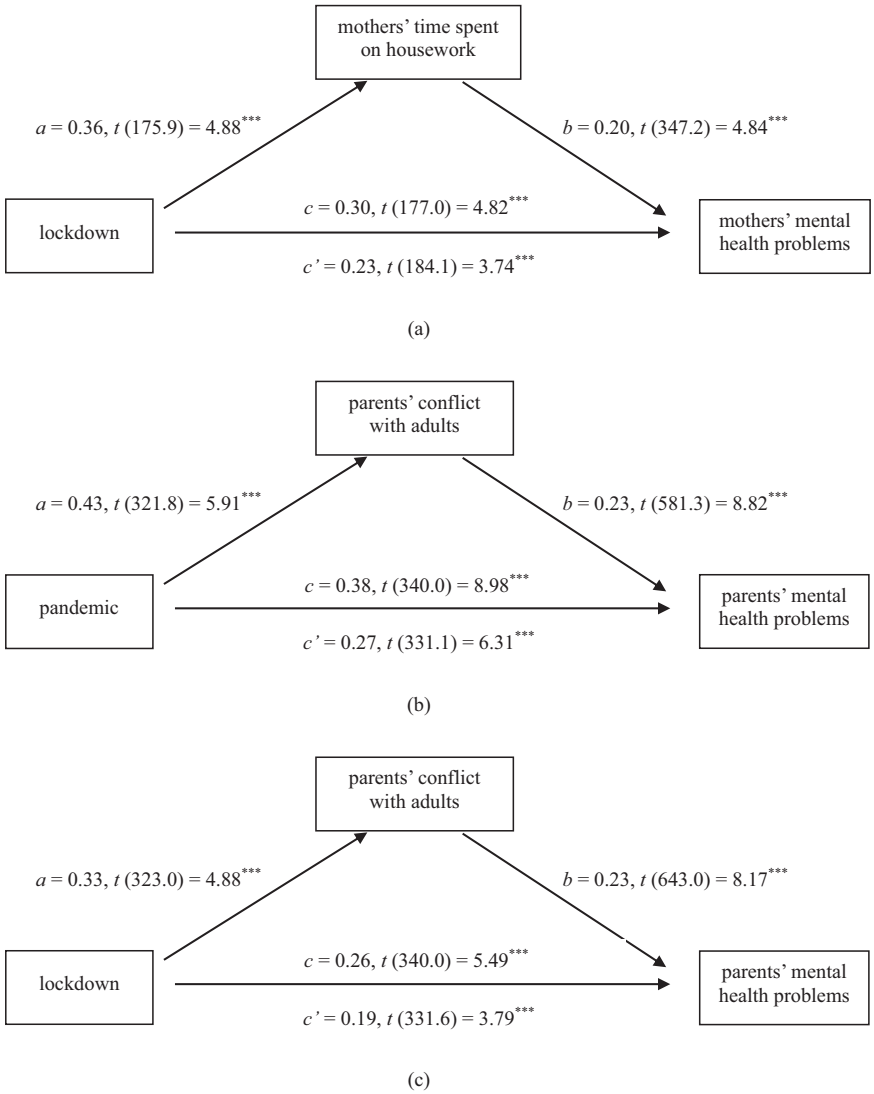


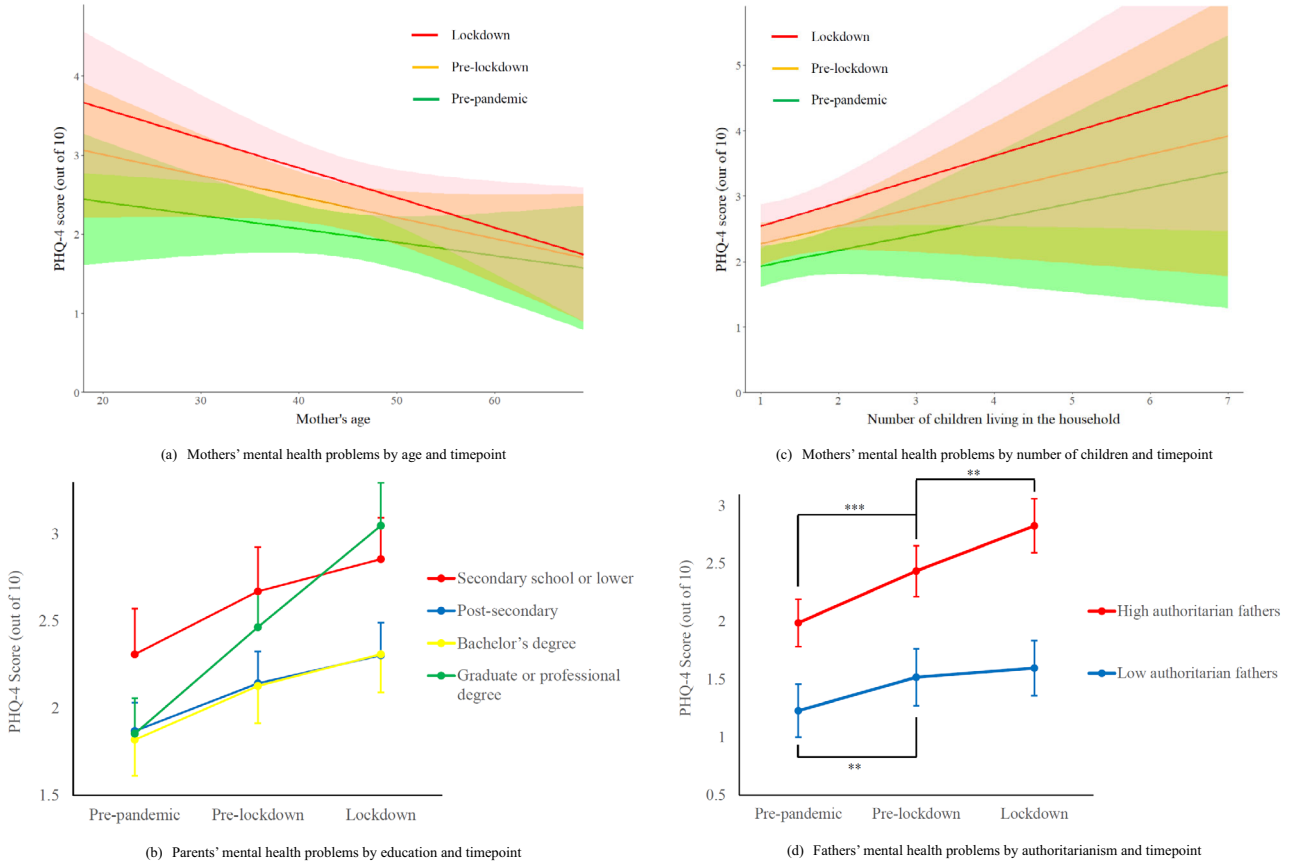
Fig. 3 Mediation analysis for the impact of pandemic and lockdown on parents' mental health. **a** Mothers' time spent on housework partially mediated the impact of lockdown on mothers' mental health problems. **b** Parents' conflict with adults partially mediated the impact of pandemic on parents' mental health problems. **c** Parents' conflict with adults partially mediated the impact of lockdown on parents' mental health problems. ***$p < 0.001$

model using timepoint, number of children, and number of children × timepoint as fix-effect variables and individual as a random-effect variable. Results showed a significant effect of timepoint, χ^2 (2) = 91.1, $p < 0.001$, but no significant effect of number of children, or number of children × timepoint interaction, χ^2 (2) < 91.18.6, $ps > 0.2$. When we separated the three timepoints (Fig. 4c), number of children did not predict mothers' mental health in any of the timepoints, $Bs < 0.36$, $ps > 0.07$. The number of children × timepoint interaction effect observed in the omnibus test may have been due to interactions between number of children and other predictors included in the model. The long-tail distribution of number of children (one family in our sample had 7 children living with them) may have also caused the results to be unstable.

Lastly, we looked at fathers' authoritarianism by fitting fathers' PHQ-4 score with a mixed-effect model using timepoint, authoritarianism, and authoritarianism × timepoint as fix-effect variables and individual as a random-effect variable. Results showed a significant effect of timepoint, χ^2 (2) = 65.6, $p < 0.001$, a significant effect of authoritarianism, χ^2 (1) = 5.2, $p = 0.02$, as well as a significant authoritarianism × timepoint interaction, χ^2 (2) = 7.8, $p = 0.02$. As shown in Fig. 4d, low authoritarian fathers' mental health problems increased significantly from Pre-pandemic to Pre-lockdown $B = 0.289$, CI = [0.087, 0.492], but did not increase significantly from Pre-lockdown to Lockdown, $B = 0.079$, CI = [−0.124, 0.282]. High authoritarian fathers' mental health problems increased significantly both from Pre-pandemic to Pre-lockdown, $B = 0.451$, CI = [0.193, 0.709], and from Pre-lockdown to Lockdown, $B = 0.391$, CI = [0.133, 0.650].

Discussion

This study set out to test three research hypotheses. Our data confirmed the first hypothesis by revealing significant



(a) Mothers' mental health problems by age and timepoint

(c) Mothers' mental health problems by number of children and timepoint

(b) Parents' mental health problems by education and timepoint

(d) Fathers' mental health problems by authoritarianism and timepoint

Fig. 4 Factors moderating the impact of pandemic and lockdown on parents' emotional well-being, including **a** mothers' age, **b** number of children living in the household, **c** parents' education, and **d** fathers' authoritarianism. Shaded areas denote 95% CI of the regression lines. Error bars denote standard error. $*p < 0.05$, $**p < 0.01$, $***p < 0.001$

changes in family dynamics, parents' daily activities and mental health throughout the early COVID-19 period. Most of these changes were observed both between Pre-pandemic and Pre-lockdown, and between Pre-lockdown and Lockdown. However, some changes were related more closely to the lockdown (e.g., childcare arrangement). Also, changes in family dynamics during the COVID-19 period were moderated by parenting values: fathers who endorse authoritarian values increased in rule setting and conflict with their children during COVID-19, and mothers who endorse authoritarian values decreased in autonomy granting (Fig. 2). For the second research question, we found that mothers' time spent on housework played a role in the increase in their mental health problems during lockdown, and parents' conflict with other adults in the household played a role in the increase in their mental health problems during both pandemic and lockdown. For the third research question, we found that younger mothers, fathers endorsing authoritarian values, and parents with graduate or professional degree were more prone to COVID-related mental health problems.

Our results indicated that families experienced major changes in income, daily routine, childcare arrangements, and family dynamics during the early COVID-19 period. Average household income decreased significantly from Pre-lockdown to Lockdown, and half of full-time employees who rarely worked from home before pandemic switched to mostly working from home during lockdown. Because of schools and daycares closing, parents spent more time with children. A breakdown of how parents spent time with children revealed that mothers spent increased time playing with children, and fathers spent increased time meeting children's basic needs during the pandemic than before the pandemic, even though the burden of meeting children's needs still mainly fell on mothers' shoulders during the pandemic. During lockdown, activities like homework tutoring also started to take up more of parents' time.

The COVID-19 pandemic also changed the ways parents interact with children. Our study is in line with previous studies in finding that overall, mothers tend to be more behaviorally controlling (Gámez-Guadix and

Almendros 2015; Kim and Rohner 2002; Mastrotheodoros et al. 2019), whereas fathers tend to hold more authoritarian values (Bornstein et al. 2011; Pratt et al. 2019; Russell et al. 2003). In addition, our study found that parental values may moderate how family dynamics change in the face of prolonged external stress. For example, decrease in autonomy granting during the COVID-19 period was only found among high authoritarian mothers, whereas increase in rule setting without explanation was only found among high authoritarian fathers. This may reflect gender differences in authoritarian behaviors between mothers and fathers: authoritarian fathers may display their authority by making rules, whereas authoritarian mothers may display their authority by making important decisions for children. Conflict between highly authoritarian fathers and their children also increased during both Pre-lockdown and Lockdown, which could be a result of increased rule-setting. Notably, none of these trends were observed for low-authoritarian parents, which suggests that rejecting authoritarian values may protect parents from confrontational interactions with their children during difficult times (Olson 2000).

Overall, parents' perceived mental health problems increased during Pre-lockdown, and increased further during Lockdown. Both mothers and fathers reported worrying most about the health and safety of family and self during the COVID-19 period. Beyond these common concerns, the major stressors were different between mothers (caring for children, limited visiting of family/relatives, and reading about negative news) and fathers (high demand from job/business, limited travelling or going outside, and financial difficulties). This suggests that in Singapore, COVID-related stress and worries largely align with traditional gender roles.

Time spent on housework was found to have a role in the increase in mothers' mental health problems during lockdown. This is in line with previous findings which showed that Singaporean mothers were more likely than fathers to suffer poor work-family balance during the lockdown, which in turn was linked with higher parenting stress and increased marital conflicts (Chung et al. 2022). The COVID-19 pandemic might have led to an increase in household-related chores, due to extended periods of time spent at home and the need to keep the home environment clean and conducive for remote working and learning. Lockdown could have also led to an even larger increase in housework due to the inability to outsource housework (Farré et al. 2020). In particular, housework burden tends to fall on mothers rather than fathers during the pandemic (Del Boca et al. 2020; Farré et al. 2020), and decreased mental health could stem from unhappiness regarding this uneven split in responsibility.

Increased conflict with adults in the household was associated with the increase in both mothers' and fathers' mental health problems during pandemic and lockdown. COVID-related stress is likely to increase maladaptive processes (e.g., hostility, withdrawal, less responsive support) which undermine couples' relationship quality (Pietromonaco and Overall 2021) and may thus result in increased conflict and mental health problems. Providing resources in marital support, relationship management, and emotional regulation to families could help in reducing conflict between adults at home and hence enhance or protect their well-being during the pandemic.

Age, education level, and authoritarian values were found to be potential moderators of the COVID-19 pandemic on parents' mental health. Firstly, younger mothers experienced a sharper increase in anxiety and depression, which is consistent with mental health studies investigating demographic indicators of age and gender (e.g., Albert 2015; Gould and Edelstein 2010; Kim and Kim 2017). Specific to COVID-19, it had been found that female gender and young age (≤40 years) were associated with mental distress during the pandemic across countries (see Xiong et al. 2020 for a systematic review). This may be due to having economic stability at an older age (González-Sanguino et al. 2020), and older parents experiencing less negative affect in response to stressful events in general (Ha et al. 2008) and child-rearing in particular (Pacilli et al. 2013).

Secondly, there was a significant education by timepoint interaction for parents' mental health. Overall, parents with secondary diploma or lower experienced the highest level of mental health problems, yet parents with graduate or professional degrees experienced the sharpest increase in mental health problems during the COVID-19 period. The high-level of mental health problems for parents with low education levels was consistent with general findings that higher education levels are related to better outcomes in caregiver psychological well-being (Raina et al. 2004). This pattern is also observed within the context of COVID-19, where lower education levels were associated with greater depressive symptoms during the pandemic (Gao et al. 2020; Mazza et al. 2020; Olagoke et al. 2020; C. Wang et al. 2020a, 2020b). The reason behind why parents with graduate or professional degrees experience the sharpest increase in mental health problems during the pandemic is more speculative. One study reported that people with higher education and professional jobs exhibited more depressive symptoms in comparison to less educated individuals and those in service or enterprise industries during the COVID-19 period (Y. Wang et al. 2020a, 2020b). It is possible that unemployment and financial strain is more severe for highly educated parents who work on professional jobs, and it is also possible that highly educated

parents face more challenges in juggling between working from home, caregiving, and household responsibilities.

Lastly, authoritarian fathers were found to be more affected by COVID-19 in terms of their mental health. This is in line with previous COVID-19 findings that anxiety, depression, and stress in parents with authoritarian parenting styles are significantly higher than parents with permissive parenting styles, with depression of authoritarian parents also being higher than authoritative parents. This may be because of conflict that arise from increased time spent with children at home and the inability of children to meet the generally higher demands of authoritarian parents (Wu et al. 2020).

In sum, results from this study suggest that both the COVID-19 pandemic and the accompanying lockdown measures posed significant social and psychological burden on families with children. These burdens can occur through direct mechanisms such as increasing parents' concerns about health and safety but can also occur through indirect mechanisms such as increasing mothers' housework load, or increasing conflict among adults in the household. Parents' exposure to COVID-related mental health problems was further moderated by demographic variables such as age and education level, as well as parenting values and practices. Finally, some of the more intuitive mechanisms, such as household income and childcare burden, did not appear to be significant predictors of parental mental health in our study. This could be due our sample being relatively homogenous on these variables, or the overlapping variance with other variables in the model.

These findings have both theoretical and practical implications. On a theoretical level, the COVID-19 pandemic, especially in the case of Singapore, provided an unfortunate opportunity of a "natural experiment" on how families function under pressure. We presented an example which showed that external stress, family dynamics and parenting values can interact with one another to impact parents' mental health. Paternal authoritarian values, for example, may moderate how family dynamics and parental mental health change such periods of stress. Future research needs to investigate the mechanisms underlying how parenting values, such as authoritarianism, impact family dynamics and mental health when the family is under other forms of stress.

In practice, these findings call for attention toward the social and psychological costs of lockdown measures. The negative impact on parents' mental health should be recognized and considered in the decision to impose such measures for infection control. These findings also point to the importance of providing support services that are most closely related to parents' mental health. For example, reopening housekeeping services may need to be prioritized, given that time spent on housework is associated with mental health problems for mothers. Marriage/family counselling may also be important given the significant role of family conflict.

A major limitation of this study is that we relied solely on retrospective self-report. These reports can be subject to biases related to social desirability (Brenner and Delamater 2014; Mortel and Thea 2008), recollection errors (Sato and Kawahara 2011; Stone and Shiffman 2002), and common method variance (Podsakoff et al. 2003). We attempted to address recollection errors by completing data collection within 1 month after the lockdown and asking about concrete daily activities before asking about more subjective feelings and experiences. Also, most variables in our study are not highly correlated with each other, which suggest that the mediation and moderation effects found in the study cannot be fully explained by spurious correlations caused by common method variance. Nonetheless, findings from this study should be treated as exploratory and need to be verified by future studies that combine self-report data with data collected by other methodologies, and ideally collected prospectively and longitudinally during the development of a crisis. Finally, future studies need to investigate the causal mechanisms underlying changes in family dynamics and family member's mental health under a prolonged period of stress.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

References

Albert, P. R. (2015). Why is depression more prevalent in women. *Journal of Psychiatry and Neuroscience*, *40*(4), 219–221. https://doi.org/10.1503/jpn.150205.

Awang, N. (2020). Singaporeans most anxious about economic issues and contracting Covid-19 in public spaces: Study. *Today*. https://bit.ly/35PNpqY.

Bornstein, M. H., Putnick, D. L., & Lansford, J. E. (2011). Parenting attributions and attitudes in cross-cultural perspective. *Parenting*, *11*(2–3), 214–237. https://doi.org/10.1080/15295192.2011.585568.

Brenner, P. S., & Delamater, J. D. (2014). Social desirability bias in self-reports of physical activity: Is an exercise identity the culprit? *Social Indicators Research*, *117*(2), 489–504. https://doi.org/10.1007/s11205-013-0359-y.

Brown, S. M., Doom, J. R., Lechuga-Peña, S., Watamura, S. E., & Koppels, T. (2020). Stress and parenting during the global COVID-19 pandemic. *Child Abuse and Neglect*, 104699–104699. https://doi.org/10.1016/j.chiabu.2020.104699.

Chung, G. S. K., Chan, X. W., Lanier, P., & Wong, P. Y. J. (2022). Associations between work–family balance, parenting stress, and marital conflicts during COVID-19 pandemic in Singapore. *Journal of Child and Family Studies*, 1–13. https://doi.org/10.1007/s10826-022-02490-z.

Conger, R. D., & Elder, G. H. J. (1994). *Families in troubled times: adapting to change in rural America*. Aldine de Gruyter: Hawthorne, N.Y.

Del Boca, D., Oggero, N., Profeta, P., & Rossi, M. (2020). Women's and men's work, housework and childcare, before and during COVID-19. *Review of Economics of the Household*. https://doi.org/10.1007/s11150-020-09502-1.

Farré, L., Fawaz, Y., González, L., & Graves, J. (2020). *How the covid-19 lockdown affected gender inequality in paid and unpaid work in spain*. IZA Discussion Papers 13434, https://doi.org/10.2139/ssrn.3643198.

Feldman, S., & Stenner, K. (1997). Perceived threat and authoritarianism. *Political Psychology*, *18*(4), 741–770. https://doi.org/10.1111/0162-895X.00077.

Fontanesi, L., Marchetti, D., Mazza, C., Di Giandomenico, S., Roma, P., & Verrocchio, M. C. (2020). The effect of the COVID-19 lockdown on parents: A call to adopt urgent measures. *Psychological Trauma: Theory, Research, Practice, and Policy*, *12*(S1), S79–S81. https://doi.org/10.1037/tra0000672.

Gámez-Guadix, M., & Almendros, C. (2015). Parental discipline in Spain and in the United States: differences by country, parent-child gender and education level/Disciplina parental en España y en Estados Unidos: diferencias en función del país, del sexo de padres e hijos y del nivel educativo. *Infancia y Aprendizaje*, *38*(3), 569–599. https://doi.org/10.1080/02103702.2015.1054665.

Gao, J., Zheng, P., Jia, Y., Chen, H., Mao, Y., Chen, S., & Dai, J. (2020). Mental health problems and social media exposure during COVID-19 outbreak. *PloS ONE*, *15*(4), e0231924 https://doi.org/10.1371/journal.pone.0231924.

González-Sanguino, C., Ausín, B., Castellanos, M., Saiz, J., López-Gómez, A., Ugidos, C., & Muñoz, M. (2020). Mental health consequences during the initial stage of the 2020 Coronavirus pandemic (COVID-19) in Spain. *Brain, Behavior, and Immunity*, *87*, 172–176. https://doi.org/10.1016/j.bbi.2020.05.040.

Gould, C. E., & Edelstein, B. A. (2010). Worry, emotion control, and anxiety control in older and young adults. *Journal of Anxiety Disorders*, *24*(7), 759–766. https://doi.org/10.1016/j.janxdis.2010.05.009.

Gov.sg. (2020). *What you can and cannot do during the circuit breaker period*. https://www.gov.sg/article/what-you-can-and-cannot-do-during-the-circuit-breaker-period.

Ha, J.-H., Hong, J., Seltzer, M. M., & Greenberg, J. S. (2008). Age and gender differences in the well-being of midlife and aging parents with children with mental health or developmental problems: report of a national study. *Journal of Health and Social Behavior*, *49*(3), 301–316. https://doi.org/10.1177/002214650804900305.

IBM Corp. (2013). *IBM SPSS Statistics for Windows, Version 22.0*. Armonk, NY: IBM Corp.

Ipsos MORI. (2020). COVID-19 and mental wellbeing. https://www.ipsos.com/ipsos-mori/en-uk/Covid-19-and-mental-wellbeing.

Kim, J., & Kim, H. (2017). Demographic and environmental factors associated with mental health: a cross-sectional study. *International Journal of Environmental Research and Public Health*, *14*(4), 431 https://doi.org/10.3390/ijerph14040431.

Kim, K., & Rohner, R. P. (2002). Parental warmth, control, and involvement in schooling: Predicting academic achievement among Korean American adolescents. *Journal of Cross-Cultural Psychology*, *33*(2), 127–140. https://doi.org/10.1177/0022022102033002001.

Kroenke, K., Spitzer, R. L., Williams, J. B., & Löwe, B. (2009). An ultra-brief screening scale for anxiety and depression: The PHQ–4. *Psychosomatics*, *50*(6), 613–621. https://doi.org/10.1176/appi.psy.50.6.613.

Leung, S.-O. (2011). A comparison of psychometric properties and normality in 4-, 5-, 6-, and 11-point Likert scales. *Journal of Social Service Research*, *37*(4), 412–421. 01488376.2011.580697.

Masarik, A. S., & Conger, R. D. (2017). Stress and child development: a review of the Family Stress Model. *Current Opinion in Psychology*, *13*, 85–90. https://doi.org/10.1016/j.copsyc.2016.05.008.

Mastrotheodoros, S., Van der Graaff, J., Deković, M., Meeus, W. H., & Branje, S. J. (2019). Coming closer in adolescence: Convergence in mother, father, and adolescent reports of parenting. *Journal of Research on Adolescence*, *29*(4), 846–862. https://doi.org/10.1111/jora.12417.

Mazza, C., Ricci, E., Biondi, S., Colasanti, M., Ferracuti, S., Napoli, C., & Roma, P. (2020). A nationwide survey of psychological distress among Italian people during the COVID-19 pandemic: Immediate psychological responses and associated factors. *International Journal of Environmental Research and Public Health*, *17*(9). https://doi.org/10.3390/ijerph17093165.

Mills, C. M., Danovitch, J. H., Mugambi, V. N., Sands, K. R., & Monroe, A. J. (2022). Cognitive reflection and authoritarianism relate to how parents respond to children's science questions. *Developmental Psychology*, *58*(3), 417. https://doi.org/10.1037/dev0001309.

Ministry of Health Singapore. (2020). *Updates on Singapore's COVID-19 situation*. https://www.moh.gov.sg/covid-19.

Mortel, V. D., & Thea, F. (2008). Faking it: Social desirability response bias in self-report research. *Australian Journal of Advanced Nursing*, *25*, 40–48.

Muthén, L. K., & Muthén, B. (2017). *Mplus: Statistical Analysis with Latent Variables: User's Guide (Version 8)*. Authors.

Olagoke, A. A., Olagoke, O. O., & Hughes, A. M. (2020). Exposure to coronavirus news on mainstream media: The role of risk perceptions and depression. *British Journal of Health Psychology*, *n/a*(n/a), e12427. https://doi.org/10.1111/bjhp.12427.

Olson, D. H. (2000). Circumplex Model of Marital and Family Systems. *Journal of Family Therapy*, *22*(2), 144–167. https://doi.org/10.1111/1467-6427.00144.

Pacilli, M. G., Giovannelli, I., Prezza, M., & Augimeri, M. L. (2013). Children and the public realm: antecedents and consequences of independent mobility in a group of 11–13-year-old Italian children. *Children's Geographies*, *11*(4), 377–393. https://doi.org/10.1080/14733285.2013.812277.

Patrick, S. W., Henkhaus, L. E., Zickafoose, J. S., Lovell, K., Halvorson, A., Loch, S., & Davis, M. M. (2020). Well-being of parents and children during the COVID-19 pandemic: a national survey. *Pediatrics*, *146*(4), e2020016824. https://doi.org/10.1542/peds.2020-016824.

Pew Research Center. (2020). *Most Americans Say Coronavirus Outbreak Has Impacted Their Lives*. https://pewrsr.ch/3oQhKhQ

Pietromonaco, P. R., & Overall, N. C. (2021). Applying relationship science to evaluate how the COVID-19 pandemic may impact couples' relationships. *American Psychologist*, *76*(3), 438. https://doi.org/10.1037/amp0000714.

Podsakoff, P. M., MacKenzie, S. B., Lee, J. Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: a critical review of the literature and recommended remedies. *Journal of Applied Psychology*, *88*(5), 879–903. https://doi.org/10.1037/0021-9010.88.5.879.

Pratt, M., Hoffmann, D., Taylor, M. & Musher-Eizenman, D. (2019). Structure, coercive control, and autonomy promotion: a comparison of fathers' and mothers' food parenting strategies. *Journal of Health Psychology*, *24*(13), 1863–1877. https://doi.org/10.1177/2F1359105317707257.

R Core Team. (2020). R: A language and environment for statistical computing. Vienna, Austria: R Foundation for Statistical Computing. https://www.R-project.org/.

Raina, P., O'Donnell, M., Schwellnus, H., Rosenbaum, P., King, G., Brehaut, J., & Wood, E. (2004). Caregiving process and caregiver burden: Conceptual models to guide research and practice. *BMC Pediatrics*, *4*(1), 1. https://doi.org/10.1186/1471-2431-4-1.

Russell, A., Hart, C., Robinson, C. & Olsen, S. (2003). Children's sociable and aggressive behaviour with peers: A comparison of the US and Australia, and contributions of temperament and parenting styles. *International Journal of Behavioral Development*, *27*(1), 74–86. https://doi.org/10.1080/2F01650250244000038.

Sato, H., & Kawahara, J.-i (2011). Selective bias in retrospective self-reports of negative mood states. *Anxiety, Stress, & Coping*, *24*(4), 359–367. https://doi.org/10.1080/10615806.2010.543132.

Sobel, M. E. (1982). Asymptotic confidence intervals for indirect effects in structural equation models. *Sociological Methodology*, *13*, 290–312. https://doi.org/10.2307/270723.

Spinelli, M., Lionetti, F., Pastore, M., & Fasolo, M. (2020). Parents' stress and children's psychological problems in families facing the COVID-19 outbreak in Italy [Original Research]. *Frontiers in Psychology*, *11*(1713). https://doi.org/10.3389/fpsyg.2020.01713.

Stewart, A. L., Hays, R. D., & Ware Jr, J. E. (1988). The MOS short-form general health survey: Reliability and validity in a patient population. *Medical Care*, 724–735. https://doi.org/10.1097/00005650-198807000-00007

Stone, A. A., & Shiffman, S. (2002). Capturing momentary, self-report data: a proposal for reporting guidelines. *Annals of Behavioral Medicine*, *24*(3), 236–243. https://doi.org/10.1207/S15324796ABM2403_09.

Tagar, M. R., Federico, C. M., Lyons, K. E., Ludeke, S., & Koenig, M. A. (2014). Heralding the authoritarian? Orientation toward authority in early childhood. *Psychological Science*, *25*(4), 883–892. https://doi.org/10.1177/0956797613516470.

Vuorre, M., & Bolger, N. (2018). Within-subject mediation analysis for experimental data in cognitive psychology and neuroscience. *Behavior Research Methods*, *50*(5), 2125–2143. https://doi.org/10.3758/s13428-017-0980-9.

Wang, C., Pan, R., Wan, X., Tan, Y., Xu, L., McIntyre, R. S., & Ho, C. (2020a). A longitudinal study on the mental health of general population during the COVID-19 epidemic in China. *Brain, Behavior, and Immunity*, *87*, 40–48. https://doi.org/10.1016/j.bbi.2020.04.028.

Wang, Y., Di, Y., Ye, J., & Wei, W. (2020b). Study on the public psychological states and its related factors during the outbreak of coronavirus disease 2019 (COVID-19) in some regions of China. *Psychology, Health & Medicine*, 1–10. https://doi.org/10.1080/13548506.2020.1746817.

Wu, M., Xu, W., Yao, Y., Zhang, L., Guo, L., Fan, J., & Chen, J. (2020). Mental health status of students' parents during COVID-19 pandemic and its influence factors. *General Psychiatry*, *33*(4), e100250. https://doi.org/10.1136/gpsych-2020-100250.

Xiong, J., Lipsitz, O., Nasri, F., Lui, L. M. W., Gill, H., Phan, L., & McIntyre, R. S. (2020). Impact of COVID-19 pandemic on mental health in the general population: a systematic review. *Journal of Affective Disorders*, *277*, 55–64. https://doi.org/10.1016/j.jad.2020.08.001.