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Original Article

Impact of work routines on parents' and children's sleep during the COVID-19 pandemic lockdown

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ABSTRACT

Objective: To evaluate the effects of parental sleep and work arrangements on children's sleep duration during the national lockdown period, referred to as 'Circuit Breaker' (CB), due to COVID-19.
Methods: Cross-sectional, anonymous, online questionnaire to parents with school-going children aged between 3 and 16 years. Child and parental sleep duration in relation to change in parental work arrangements, housing type and number of individuals in the household as reported by parents were evaluated. Descriptive statistics and tests of comparison were used to evaluate data.
Results: School-going children (n = 593) had a mean age of 8.68 (SD = 3.65; median 7) years. Both, fathers and mothers had gains in sleep during CB (based on self-reported sleep data), compared to pre-CB. Change in both maternal and paternal sleep duration positively correlated with change in child sleep duration (based on parent-reported sleep data) among all children ($r^2 = 0.27$, $p < 0.001$ and $r^2 = 0.17$, $p < 0.001$ respectively); pre-schoolers mirrored their mothers' sleep more closely. Parents who changed to working from home during the CB (compared to working from outside home previously) had the greatest gains in sleep during this period. Housing type was not significantly associated with change in child sleep duration from pre-CB to CB.
Conclusions: Greater gains in sleep in parents was associated with working from home during CB. Child sleep duration mirrored gains in parental sleep, especially in pre-school and primary-school-going children. Optimising parental sleep may therefore be one of the means to improve child sleep.

1. Introduction

Sleep is an essential component of human life. It is part of our biological rhythm and helps to restore important functions of our lives including physiological and biochemical functions [1–4]. Sleep associated issues, including inadequate sleep duration and sleep related breathing disorders, are known to have ill effects on children's cognition, memory and some aspects of physical health [5–9]. This is an especially pertinent issue in Asia, where children have been shown to have shorter sleep duration compared to their Western counterparts [10–12].

Sleep is a multifactorial phenomenon known to be influenced by several social and cultural factors. In children, these factors include family and parent-related factors as well as school-related ones. For example, socio-economic status (SES) factors that govern bed or room sharing and sleeping arrangements may impair bedtime schedules and in turn, sleep in children [13,14]. Parental sleep quality and quantity, especially among mothers has been shown to influence sleep in children previously, particularly in infants [15]. School-related factors such as homework and school start times [16] also contribute to sleep disruption in children [17–20]. All these factors taken together represent a complete family environment that as a whole can influence sleep in children [14,17,21,22].

The ongoing COVID-19 pandemic has had a significant impact on normal sleep patterns in children worldwide, including in Singapore [16,23,24]. Reports from various countries have

Abbreviations: Circuit Breaker, CB; Socio economic status, SES.

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suggested varied results, with some reporting an increase in nocturnal sleep duration in children with others reporting no significant changes [25]. In addition, consequent movement restrictions implemented in many countries worldwide have led to marked changes in parental work arrangements and daily routines. These have the potential to impact child sleep due to changes within the family environment. For instance, in China, a recent study showed significant positive associations between better parent-child communication and family atmosphere on child sleep during the pandemic [24]. In Singapore, a period of strict curtailment in all but essential services, termed 'Circuit Breaker (CB)' was implemented as part of pandemic control measures. This involved closure of all but essential services, with the majority of individuals working from home and children learning from home. This provided a unique opportunity to study children's sleep in the context of parental sleep, work arrangements and other factors. The aim of this study was to examine the effect, if any, of parental sleep and work arrangements on children's sleep duration.

2. Materials and methods

2.1. Study design

This is a cross-sectional study of participants using an open survey questionnaire during the national CB period from 7th April 2020 to 1st June 2020. Inclusion criteria were that of parents aged 21 years and above with children aged between 3 and 16 years attending preschool, primary or secondary school and residing in Singapore. The education system in Singapore is such that children attend primary school (age 7–12 years) and secondary school (age 13–16 years) before the start of tertiary education at the age of 16–18 years. An additional group of parents with infants and non-school-going children aged between 6 months and 3 years were also invited to participate in the study (please see Supplementary material for survey questionnaires used for School going children and Infants/toddlers). Eligible participants were recruited via email flyers, advertisements on social media (Facebook), and messaging platforms (WhatsApp). Recipients of the survey questionnaire link were encouraged to disseminate the invitation to other eligible contacts. Implied consent was obtained when participants completed the voluntary anonymous questionnaire.

The study was reviewed for ethical considerations and approved by the hospital's institutional Domain Specific Review Board.

2.2. Study measure

The study questionnaire was hosted on a secure online platform and included questions on 1) child demographic data (age, education level), child sleep data (parent-reported) 2) parent sleep data (self-reported) (bedtimes before and during CB, work arrangements including change in work schedules due to CB) and 3) housing type, number of household family members as well as information on child activities before and during CB including physical activity and screen time. Housing type has been used as a surrogate of SES in previous studies done in Singapore [26] and hence, in the current study, we used it as a marker of SES. Parents were also asked about their perception of factors which influenced their child's sleep. To avoid confusion, separate sets of questions were used to collect information on the pre-CB period and during CB period. The study e-flyer invitation that was shared with participants advised them to complete one survey per child, expecting that if there were more than 1 child in the household, parents would fill a separate survey questionnaire for each child.

2.3. Analysis

All returned questionnaires were analyzed. Descriptive statistics were used to examine child and parental sleep data pre-CB and during CB. The analysis was also stratified based on children's school level (pre-school, primary school, and secondary school) and by parental work arrangements by comparing the mean difference of sleep hours across groups. The presentation of the data for the subset of children (infant/toddler group) was limited to the descriptive statistics and the data was not merged with the school-going children for further statistical analysis. The reason being, the subset of children (infant/toddlers) was surveyed separately with a different questionnaire, with questions customized to the activities of the infants. We also anticipated different sleep profiles for this group of children with varying contributing factors since they were not attending school.

Average sleep duration per day was calculated for pre-CB by averaging the weekday and weekend sleep duration using the formula (5 × average weekday duration + 2 × average weekend duration)/7.

Data was analysed with SPSS Statistics version 26 (IBM) [27]. Descriptive statistics were used to examine demographic variables of interest and sleep duration. Tests for normality were conducted which showed that sleep duration and other data of interest were all normally distributed. Hence tests of comparison, namely, one-way ANOVA was used to analyze for significant differences in parental sleep based on 1. their pre-CB work arrangements, 2. change in work arrangements during CB and 3. change in child sleep in relation to parental change in work arrangements. Paired sample t-tests were used to assess for sleep differences in parents pre-CB and during the CB period. Tests for correlation between child and parental sleep was conducted using Pearson correlation. Statistical significance was set as a p value of <0.05.

3. Results

3.1. Participant characteristics

A total of 593 responses were analyzed from parents of school-going children. An additional subset of 74 responses from parents with infants and non-school-going children (6 months–3 years old) was analyzed separately where applicable due to inherent differences that can be expected, as described in the methods section, and also because of the small sample size.

The mean (SD) age of school going children was 8.68 (3.65) years, with a median age of 7 years. There was a fair distribution of children across the different school levels with 23.4% in pre-school, 56.7% in primary school and 19.9% in secondary school. Table 1 shows the demographic characteristics of participants.

3.2. Parental sleep

Both, fathers and mothers slept longer during CB, compared to pre-CB. Mothers' mean (SD) sleep duration increased from 7.42 (0.93) hours pre-CB to 7.81 (1.14) hours during CB ($t(592) = -10.65$, $p < 0.001$, Cohen's $D = -0.458$). This was due to later waking times in the morning during the CB, despite bedtimes being slightly later during this period as well. Similarly, fathers woke up later during CB and this in turn contributed to an increase in mean (SD) sleep duration from 7.46 (0.93) hours pre-CB to 7.77 (1.05) hours during CB ($t(577) = -8.04$, $p < 0.001$, Cohen's $D = -0.340$). Maternal and paternal sleep duration correlated with each other across all children's age groups ($r^2 = 0.37$, $p < 0.001$).

Table 1
Demographic characteristics of participants.

No of response	School going children	Infants
	593	74
Respondents, n (%)	Mother: 510 (86.0%) Father: 83 (14.0%)	Mother: 66 (89.2%) Father: 8 (10.8%)
Child's age, years	Mean (SD): 8.68 (3.65) Median: 8.0 Range: 2–16	Mean: 1.58 (0.86) Median: 1.42 Range: 0.5–4
School, n (%)	Pre-school: 139 (23.4%) Primary school: 336 (56.7%) Secondary school: 118 (19.9%)	Not applicable
Housing	Private housing: 332 (56.0%) Public housing: 261 (44.0%)	Private housing: 32 (43.2%) Public housing: 42 (56.8%)
No of adults in the house	Mean (SD): 3.07 (1.29) Median: 3	Mean (SD): 2.96 (1.21) Median: 3
No of children in the house	Mean: 1.92 (0.92) Median: 2	Mean (SD): 1.18 (0.82) Median: 1

3.3. Parental sleep and child sleep

Scatter plot depicting changes in child sleep in relation to changes in parental sleep (across all school-going age groups) is presented in Fig. 1. The detailed, precise data on children's sleep timings, including their bedtime and sleep time were provided in the earlier paper by Lim et al. [16].

Change in maternal sleep duration was positively correlated with change in child sleep duration among all school-going children ($r^2 = 0.27$, $p < 0.001$). Among all children, those whose mothers slept more, had gains in sleep during CB. This was attributable largely to pre-schoolers mirroring their mother's sleep most closely, as secondary and primary school children slept more during CB irrespective of maternal sleep duration (Fig. 2).

Change in paternal sleep duration was also positively correlated with change in child sleep duration among all school-going children, although to a weaker extent compared to mothers ($r^2 = 0.17$, $p < 0.001$). This was contributed to predominantly by primary school children, who had a significant increase in sleep duration if their fathers slept more (mean (SD) of +0.61 (0.77) hours in primary school children comparing to +0.29 (0.92) hours in secondary school children and +0.14 (0.72) hours in preschool children) (Fig. 3).

Among infants, change in sleep duration was strongly correlated with change in maternal sleep duration ($r^2 = 0.50$, $p < 0.001$); however, it was not correlated with paternal sleep duration ($r^2 = 0.20$, $p = 0.09$).

3.4. Parental sleep and their work arrangements during CB

At baseline (pre-CB), the average sleep duration in either parent did not differ significantly based on work arrangements. Comparing the three categories of work arrangement: those who worked outside of home with those who worked from home and those who did not work; mean (SD) sleep in fathers in the 3 groups were 7.69 (1.00) hours vs 7.43 (0.91) vs 7.51 (1.16) hours ($p = 0.18$, Eta-squared = 0.006) and mean (SD) sleep in mothers in the 3 groups were 7.44 (1.14) hours vs 7.41 (0.85) hours vs 7.43 (1.02) hours ($p = 0.96$, Eta-squared = 0.000) respectively. However, during CB, both fathers and mothers who worked outside home had less sleep as compared to those who worked from home or did not work. For example, fathers who worked outside of home (n = 133) had a mean (SD) of 7.49 (1.02) hours of sleep as compared to 7.80 (1.02) for those who worked from home (n = 399) and 8.14 (1.35) for those who did not work (n = 47) ($p < 0.001$, F = 7.76, df = 2, Eta-squared = 0.026). Similarly, mothers who worked outside of home (n = 104) had a mean (SD) of 7.70 (1.19) hours of sleep as compared to 7.96 (1.03) hours in those who worked from home (n = 320) and 8.02 (1.01) hours in those who did not work (n = 169) ($p = 0.04$, F = 3.22, df = 2, Eta-squared = 0.020).

Parental work arrangements during the CB period were categorized into 4 groups for analysis: Group 1: those who used to work outside home but changed to working from home; Group 2: those who did not have a change in work arrangement during the CB (ie continued to work either outside or from home); Group 3: those who were not working pre-CB and during CB; and Group 4: those who stopped employment during the CB.

As shown in Table 2, mothers in Group 3 (ie those who did not work pre and during CB) had the highest amount of gain in

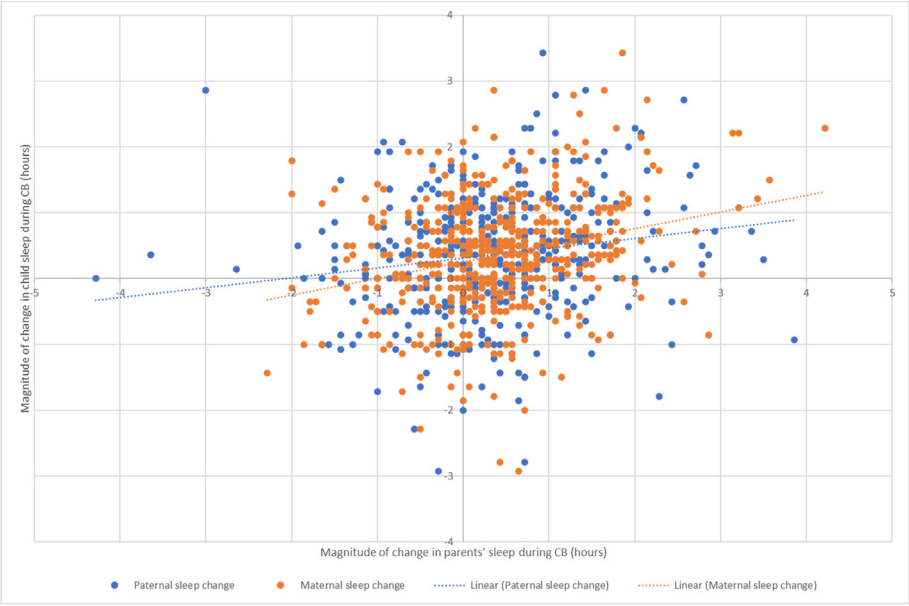

Fig. 1. Scatter plot depicting change in child sleep in relation to change in parental sleep (across all school-going age groups).

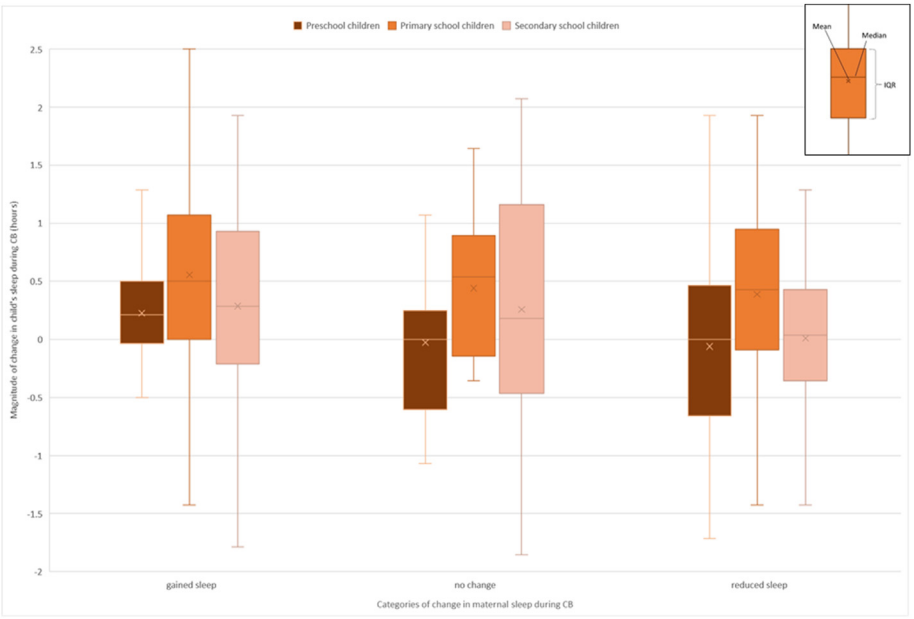

Fig. 2. Change in child sleep in relation to maternal sleep change (CB = Circuit breaker).

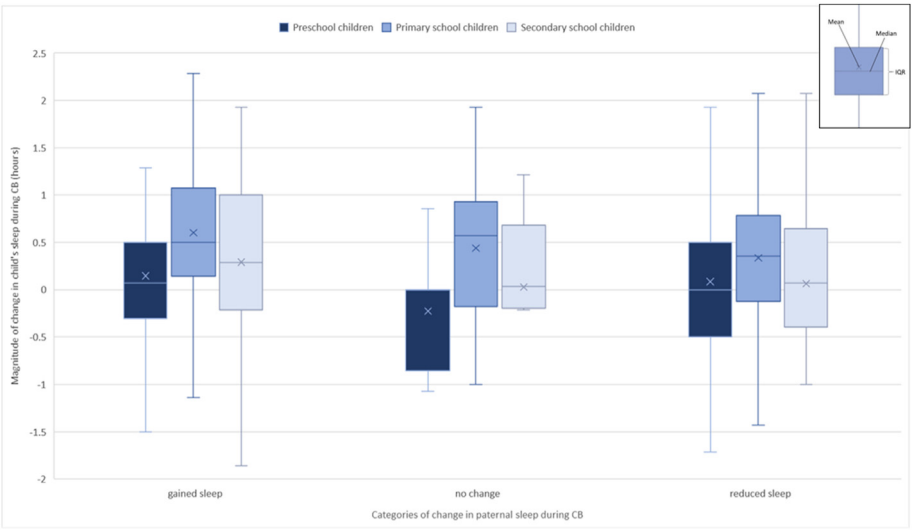

Fig. 3. Change in child sleep in relation to paternal sleep change (CB = Circuit breaker).

Table 2
Change in parental work arrangements (Mother, n = 588; Father, n = 576) and parental sleep during CB.

Nature of change in work arrangements	Change in bedtime, mean (SD)		Change in awake time, mean (SD)		Change in total sleep duration, mean (SD)	
	Mother	Father	Mother	Father	Mother	Father
Group 1: Changed from working outside to working from home						
Mother, n = 263	0.26	0.20	0.66	0.57	0.39*	0.36**
Father, n = 351	(0.69)	(0.67)	(0.77)	(0.72)	(0.87)	(0.86)
Group 2: No change in work arrangements						
Mother, n = 156	0.08	0.13	0.30	0.27	0.22*	0.15**
Father, n = 178	(0.55)	(0.54)	(0.77)	(0.81)	(0.90)	(0.91)
Group 3: Not employed both pre-CB and during CB						
Mother, n = 143	0.20	0.34	0.81	0.65	0.61	0.31
Father, n = 17	(0.62)	(0.81)	(0.72)	(0.76)	(0.86)	(1.21)
Group 4: Ceased employment during CB						
Mother, n = 26	0.40	0.24	0.65	0.83	0.25	0.60
Father, n = 30	(0.80)	(0.74)	(0.73)	(0.93)	(0.84)	(1.23)

*$p = 0.04$, **$p = 0.007$.

nocturnal sleep during CB (mean (SD) 0.61 (0.86) hours), followed by those in Group 1 (mean (SD) gain 0.39 (0.87) hours) (initial one-way ANOVA $p = 0.0437$, Eta-squared = 0.011). In both groups, the gain in sleep was primarily driven by later wake-up times in the morning, although they also went to bed later at night. Mothers who changed to working from home had greater gains in sleep compared to those who did not have a change in work arrangement (0.39 vs 0.22 h, t-test *t(417) = 2.09, p = 0.01, Cohen's d = 0.372*). Those who stopped employment during CB had lower gains in sleep compared to those who never worked and those who changed to working from home during the CB.

Fathers in Group 4 (ie those who stopped employment during CB) had the largest gain in sleep (mean (SD) 0.60 (1.23) hours) followed by those in Group 1 (mean (SD) gain 0.36 (0.86) hours), one-way ANOVA result $p = 0.007$ (Eta-squared = 0.017). Again, fathers who changed to working from home (Group 1) had greater gains in sleep compared to those who did not have a change in work arrangement (0.36 vs 0.15 h, t-test t (527) = 2.69, $p = 0.004$, *Cohen's d = 0.336)*.

While all schools were closed during CB, the presence of a stipulated fixed start time for online lessons did not significantly affect change in either parent's sleep duration. (ANOVA -mothers $p = 0.29$ Eta-squared = 0.003; fathers $p = 0.65$, Eta-squared = 0.001).

3.5. Parental change in work arrangement and child sleep

When child sleep statistics were grouped according to mothers' changes in work arrangements, there was no significant difference in child sleep when correlated with the various groups of mother's work arrangement (Table 3). Children of mothers who stopped working during CB had the lowest gain in sleep.

Children of fathers who did not work both before and during the CB (Group 3) had the greatest gains in sleep during the CB (mean (SD) change 0.80 (0.89). This was followed by children of fathers who stopped working during CB (Group 4) who gained an average of 0.45 h of sleep (SD 1.00). Although this difference was not statistically significant, the overall ANOVA was approaching significance at $p = 0.051$ (Eta-squared = 0.014) (Table 3).

3.6. Impact of type of housing on child's sleep

Participants' responses were analysed according to the family's type of housing (public vs private housing). Type of housing did not correlate with children's change in sleep duration during the CB period among pre-schoolers, primary school or secondary school going children. There was also no significant association between number of individuals in the household and children's sleep.

Table 3
Change in child sleep with respect to paternal change in work arrangements.

Nature of change in work arrangements	Change in child sleep	
	Maternal work change	Paternal work change
Group 1: Changed from working outside to working from home	n = 263 0.35 (0.83)	n = 351 0.30 (0.78)
Group 2: No change in work arrangements	n = 156 0.35 (0.83)	n = 178 0.41 (0.85)
Group 3: Not employed both pre-CB and during CB	n = 143 0.35 (0.75)	n = 17 0.80 (0.89)
Group 4: Ceased employment during CB	n = 26 0.20 (0.94)	n = 30 0.45 (1.00)
One-way ANOVA comparison between all 4 groups	*p* value: 0.84 F = 0.280 d.f = 3	*p* value: 0.05 F = 2.61 d.f = 3

3.7. Parental perception of children's sleep

Among school going children, removal of school start times (72.0%) and not having to travel to and from school (72.0%) were the top ranked factors that were felt to affect the child's sleep). Increased screen time use for leisure activities was also an important factor that was chosen by 60% of participants.

Among infants, the two highest rated factors that were perceived to affect the sleep were 1) Change in the daily routine of the child (59.5% of participants) and 2) Parents working from home (53.2% of participants).

4. Discussion

COVID-19 related pandemic measures had far-reaching impacts on various aspects of everyday life including sleep of individuals. Our main findings show that, parents of school-going children slept better during CB; employment in terms of working from home and not having to work during CB both contributed to this gain in sleep. Gains in parental sleep were correlated with gain in child sleep. This was especially so in younger children. Housing type and number of household members did not have significant impact on children's sleep based on our limited data.

Our findings that parents slept more during CB is similar to that from studies done among adults in other countries such as Brazil and across Europe during national pandemic lockdowns [23,28]. In addition, this gain in sleep was reported to be contributed by later wake-up times as seen in our study. Further, our results highlight the effect of work arrangements on sleep gains. It is not surprising that those who did not have to work or who worked from home had the greatest gains in sleep; this suggests that the work-place commute is likely an important factor dictating earlier wake times in working adults. This is similar to findings from Italy and the United States of America, where cessation of work or being able to work from home were found to be favorably associated with gains in sleep duration [23,29]. As we continue to combat the pandemic while working towards a new-normal, it is likely that continued exploration of ways to allow parents to work from home has the additional benefit of contributing to increasing their sleep duration. Although our dataset could not differentiate the impact of other-CB related factors such as child home-based learning on parental sleep, the magnitude of sleep gain in parents with a change in work arrangement was higher compared to those who did not have changes in work arrangement. This suggests a contributory effect of work arrangements on parental sleep in addition to other CB-related factors such as school closure.

Another significant finding was the association between parental and child sleep. This was especially pertinent for infants and pre-schoolers as children in both these groups slept more when their mothers had more sleep. This highlights the complex relationship between child sleep and parent sleep and possibly the greater family environment. Previous studies have illustrated the effect of maternal sleep on child sleep even prior to the pandemic, particularly in infants [15]; we add to this by showing associations between fathers' sleep and child sleep as well. It is interesting that this latter association was found specifically in primary-school going children. This could plausibly reflect the dynamics within the family whereby mothers are responsible for the younger children and fathers for the slightly older (but still dependent) primary-school going children. Not surprisingly, secondary school children did not have their sleep associated with parental sleep. This is consistent with sleep habits of this older age group which is largely independent of that of the family. We did not find any

significant associations between household environment such as housing type and number of household members on children sleep. This may suggest a greater importance of parental sleep habits and child factors like removal of school start times (as shown by our team in another study) [16] rather than physical household factors on child sleep.

Clinical implications of our findings include the need to include parental sleep habits and work arrangements in any conversation or education on child sleep. Given the crucial role that parents serve as role-models for their children, being aware of their own sleep habits and shaping them positively can lead to better sleep duration, especially in younger children. Further, in the context of the pandemic, as we re-tune lifestyles to adapt to the 'new-normal' continued provisions for parents to work from home will be important to enable them to continue to optimize their sleep.

Our study has several limitations. The cross-sectional questionnaire-based nature of data collection may limit accurate inference of changes of sleep patterns pre- and during CB as opposed to other quantitative methods such as sleep actigraphy; however, this allowed for rapid data collection despite the curtailment in activities during the unprecedented CB period and has been employed by other studies [30,31]. Also, we did not assess the construction, validity and reliability of the online survey questionnaire that we used. Due to time sensitive nature of the study, we did not have an opportunity to validate the questionnaire prior to administering it. However, we tried to build the questionnaire as clearly and objectively as possible with the provision of options to select from for most questions to avoid confusion and optimize accuracy of the data obtained. We do acknowledge the potential bias, and accuracy/reliability problems associated with using the self-reported recall of sleep especially for pre-CB period. However, this has been a widely used method for obtaining sleep data in the earlier studies [23,25,30,31]. It does provide a good method to compare with the baseline data, specifically when the questionnaire tries to gather two time point data (for example, pre and post/during) from the same individual. To our best, we tried to ask precise questions for the retrospective sleep data to minimize cognitive burden on the respondents in order to get more reliable estimates and also since the time lag between the pre and during CB data was not large, we anticipate that the data provided is accurate and reliable [32]. We also recognize that our data-set spans multiple age groups across school-going children and parental report of sleep-in adolescents may not necessarily be reliable. However, at least among preschoolers in Singapore, co-sleeping is prevalent and is seen in up to 80% of children based on prior studies [10]. Also, since the survey questionnaire did ask for precise sleep and wake time before and during CB rather than allowing parents to qualitatively state the change in sleep, we strived to improve accuracy of reported data. Lastly, we did not collect data on sleep quality (to deliberately keep the questionnaire concise), which is another important aspect of sleep beyond sleep duration alone.

Despite these limitations, we believe the strength of the study lies in the scenario presented by the circuit breaker implemented due to the pandemic. The circuit breaker created a scenario that mimicked an experimental situation where the families were now in a situation where they had to change their routines and work/study from home. It gave us an opportunity to study a scenario that cannot be otherwise created for the purposes of research where families are made to work/study from home, yet allowed us to study how changes in these routines impacted sleep. Hence, we believe the data on sleep duration gathered from this study serves as a starting point to reveal some of the contributing factors to child sleep and can be built upon in further studies.

In conclusion, the ongoing pandemic and its influence on parental schedules and work arrangements is associated with changes to both parental sleep and child sleep. Optimizing parental sleep will be important to enhance sleep in children, especially among the younger ones. Promoting work from home, where possible, may enhance parental sleep, and hence child sleep, an important consideration, as we work towards a new-normal post COVID-19 pandemic.

Authors' contributions

Ramkumar Aishworiya - Contributed in Methodology, Investigation, Wrote Original Draft, Project administration; Michael Teik Chung Lim- Contributed in Methodology, Investigation, Reviewed and edited the manuscript, Project administration; Mahesh Babu Ramamurthy- Contributed in Methodology, Formal analysis, Investigation, Reviewed and edited the manuscript, Project administration, Anh Phuong Tran - Contributed in Investigation, Data Curation, Visualization, Reviewed and edited the manuscript, Project administration; Dimple D Rajgor - Contributed in Methodology, Investigation, Reviewed and edited the manuscript, Project administration; Daniel Yam Thiam Goh- Contributed in Conceptualization, Methodology, Investigation, Reviewed and edited the manuscript, Project administration

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Disclosure:prior publication using same dataset

We would like to disclose that we have previously published a paper entitled "Lim MTC, Ramamurthy MB, Aishworiya R, Rajgor DD, Tran AP, Hiriyur P, Kunaseelan S, Jabri M, Goh DYT. School closure during the coronavirus disease 2019 (COVID-19) pandemic—Impact on children's sleep. Sleep Medicine 2021;78:108-114" using the same dataset. However, the research questions that were addressed in the earlier paper and in the current manuscript are different and do not overlap in any way. Additionally, the current manuscript also includes data collected for infants (that were not included in earlier publication since that study specifically focused on schools closure and school-going children only). The citation of the earlier published paper is included in the current manuscript.

Conflict of interest

None.

The ICMJE Uniform Disclosure Form for Potential Conflicts of Interest associated with this article can be viewed by clicking on the following link: https://doi.org/10.1016/j.sleep.2021.10.005.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.sleep.2021.10.005.

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