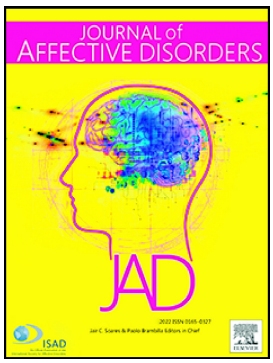

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Influence of Lifestyle and Family Environment Factors on Mental Health Problems in Hong Kong Preschoolers

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ABSTRACT

Background and aims: Existing studies that simultaneously consider the effects of lifestyle and family environment factors on mental health problems (MHPs), particularly in preschoolers, are limited. This study aims to explore lifestyle and family environment factors associated with MHPs, externalising problems (EPs) and internalising problems (IPs) in preschoolers.

Methods: This territory-wide, school-based study conducted from 2020 to 2022 involved 1926 preschoolers. MHPs, EPs, and IPs and factors such as sleep duration, sleep latency, entertainment screen time, educational screen time, parent-child recreation and learning activities were assessed. Linear and logistic regression analyses were used to explore the relationships between these factors and MHPs, EPs, and IPs.

Results: The average sleep duration was 9.94 hours per day, average screen time of 2.53 hours per day, and 42.6% experienced sleep latency exceeding 20 minutes per day among preschoolers (mean age: 4.39 years, 49.1% female). Adjusted analyses showed that decreased parent-child recreation activities, prolonged sleep latency and excessive entertainment screen time were associated with increased MHPs, EPs, and IPs (β: 0.05 to 0.20, all $p<0.05$). Weekend sleep duration of less than 10 hours per day, sleep latency of more than 20 minutes per day, and educational screen time of more than 30 minutes per day were identified as risk factors for MHPs, EPs, and IPs, with an adjusted odds ratio ranging from 1.32 to 2.32 (all $p<0.05$).

Conclusions: Preschoolers' lifestyle and family environment factors are associated with MHPs, EPs, and IPs respectively. Ensuring adequate sleep duration, avoiding sleep latency exceeding 20 minutes per day, reducing entertainment screen time, limiting educational screen time to 30 minutes per day, and increasing parent-child interactions may help to minimise mental health problems.

Keywords

Mental health; parent-child activities; screen time; sleep; preschoolers

List of abbreviations

CPCIS: Chinese parent-child interaction scale

EP: Externalising problem

IP: Internalising problem

MHP: mental health problems

SDQ: Strengths and Difficulties Questionnaire

SES: Socioeconomic status

INTRODUCTION

Mental health problems (MHPs) in children and adolescents are an important public health issue due to their high prevalence, early onset, and impact on the child, family, and community (1-3). Globally, about 10% of children and adolescents were affected by at least one mental illness, accounting for a huge burden on the health care system (4). Emerging evidence further suggests that MHPs could be traced back to preschool age (3 to 4 years old) (5). In fact, preschool age is a critical period in children's brain development with the highest brain plasticity when compared to later life stages (6). It is also a common period for the onset of Internalising problems (IPs) such as anxiety and fears as well as externalising problems (EPs) like aggressive and oppositional behaviours (7-9). Studies have demonstrated that MHPs can be reliably assessed in preschoolers (10), with approximately 1 in 6 preschoolers experiencing emotional, behavioural, and/or relationship problems (11). A large-scale study in Hong Kong (HK) showed that

preschoolers were more vulnerable to the environmental changes during the COVID-19 pandemic and exhibited more MHPs compared to older children (6). Longitudinal research indicates that preschoolers with MHPs, if remain untreated, often have a high risk of developing severe mental illnesses in later life stages (12, 13). Persistent MHPs not only impact daily functioning (14), but also relate to impairments in social and cognitive development, increased conflicts with peers, and lower levels of academic competence and performance (15). Therefore, identifying risk and protective factors for MHPs in preschoolers is essential for developing early targeted and effective programs to avoid more severe impairments in adolescence or adulthood.

Several modifiable lifestyle and family environment factors, such as screen time, sleep duration, sleep latency and parent child interactive activities have been reported to be associated with MHPs, EPs and IPs among preschoolers. Research has found that preschoolers exposed to more screen time, particularly entertainment screen time have a higher risk for MHPs (16, 17). Previous cross-sectional studies found that preschoolers who had short sleep were more likely to experience EPs (18), MHPs (19), affective regulation problems (20) and developmental behaviour problems (21). A longitudinal study found that sleep latency at 30 months positively predicted higher level of negative affect one year later (22) . Moreover, shorter sleep duration and longer sleep latency have been linked to having more depressive symptoms in preschoolers (23). Sleep is necessary not only for the health unfolding of brain plasticity processes but also for the development of mental health in early life (24, 25). However, a population-based survey in Hong Kong reported a significant decline in sleep duration and an increase in sleep latency among preschoolers between 2012 and 2018 (26). A study conducted by So et al. found that

school closures during the pandemic had a lasting impact on sleep disturbances and prolonged screen time in school-age children (27). This raises concerns regarding inadequate sleep duration, prolonged sleep latency and excessive screen time, which have all been associated with adverse mental health among preschoolers. The parent child interactive activities are also considered a critical factor influencing children's mental health (28). High quality parent child interaction fosters a nurturing environment that not only strengthens family bonds but also enhances children's socioemotional skills (29). A previous intervention study indicated that increasing the parent child interaction can reduce preschoolers' problem behaviours, depressive symptoms and aggressive behaviours (30).

While many existing studies have examined the relationship between sleep duration, sleep latency, screen time, parent child interactive activities and preschoolers' mental health, most have typically focused on one or two aspects of these factors. In addition, few studies have simultaneously considered the effects of all these factors on both EPs and IPs in preschoolers. To address these limitations and gain a more comprehensive understanding of the effects of lifestyle and family environment factors on preschoolers' MHPs, EPs and IPs, this study aims to examine the association of lifestyle factors (sleep duration, sleep latency and screen time) and the family environment factor (parent child interaction) with MHPs, EPs and IPs in preschoolers.

METHODS

Study design and participants

This cross-sectional and school-based study was conducted as a part of the Hong Kong Growth Study and a contemporary community study. Comprehensive details regarding these two studies

are available in earlier publication (31). To enhance the representativeness of the recruited sample, five kindergartens in each of HK's five major regions were randomly selected using computer-generated numbers based on the respective number of schools in each region. If a selected school refused to participate in this study, the subsequent school in the random selection process was invited to replace it. Data for the current study was collected from 2020 to 2022.

All children in the randomly selected classrooms of the participating schools were invited to join this study. Children (i) with diagnosed physical and mental health conditions or (ii) who are non-Chinese speakers were excluded from the study. Trained research staff were granted permission by the kindergarten principal to distribute hardcopy questionnaires to parents or guardians of each preschooler. The questionnaire contains items on mental health, parent child interaction, child's wake-up and bedtime, sleep latency and electronic device usage. Informed consent was obtained from all parents or guardians who completed the questionnaires.

Ethics approval

Ethics approval for the study was obtained from the Joint Chinese University of Hong Kong-New Territories East Cluster Clinical Research Ethics Committee (CREC ref. no. 2019.575), the University of Hong Kong-Hospital Authority Hong Kong West Cluster Joint Institutional Review Board (UW 18-593, UW 17-491), and the Ethics Committee of the Department of Health, Hong Kong SAR Government (LM 307/2018).

Measures

Screen time

The parents or guardians reported their children's screen time through the following questions: 'How much average time does your child spend on the following activities on weekdays and weekends?' (a) Watching TV; (b) Playing games on a game console; (c) Playing games on a portable game console; (d) Doing homework or learning on a computer, iPad and cell phone; (e) Playing games on a computer, iPad and cell phone; (f) Browsing Facebook and Weibo pages on a computer, iPad and cell phone. The educational screen time was calculated by aggregating the time spent on homework or learning on a computer, iPad, and cell phone during weekdays and weekends. Similarly, the entertainment screen time was determined by summing the time spent on watching TV, browsing Facebook and Weibo, and playing games on portable game consoles, computers, iPads and cell phones throughout the week. The average screen time, measured in minutes, was calculated by averaging the reported screen time for weekends and weekdays using the weighted average formula:

$$[(5 \times \text{screen time on weekday}) + (2 \times \text{screen time on weekend})] \div 7$$

Additionally, educational screen time was categorized into two groups (≤30 vs >30minutes per day) based on the distribution of participants across the subgroups (79.6% vs 20.4%). This cutoff was chosen to ensure consistency and comparability between the subgroups, allowing for a meaningful analysis and interpretation of the results.

Entertainment screen time was also categorized into two groups (≤60 vs >60minutes per day), according to the American Academy of Paediatrics guidelines, which recommend limiting screen use to one hour per day for children aged 2 to 5 years (32).

Sleep duration and latency

Sleep duration was assessed using two questions, such as: (a) "What time does your child usually go to bed on weekdays and weekends?"; (b) "What time does your child usually get up on weekdays and weekends?". These questions were used to determine the duration of nighttime sleep on weekdays and weekends, respectively. Sleep duration was the time difference between wake-up time and bedtime. Average daily sleep duration was calculated using the weighted average formula:

$$[(5 \times \text{sleep duration on weekday}) + (2 \times \text{sleep duration on weekend})] \div 7$$

Sleep duration was categorized into two groups (<10 vs ≥10 hours per day), according to the National Sleep Foundation recommendation of 10-13 hours of sleep duration per day for preschoolers (33). In addition, sleep latency was assessed with a question: How much time does it usually take for your child to fall asleep in bed? The answer was rated from 1 to 5 (1 = "< 5 minutes", 2 = "6 - 20 minutes", 3 = "21 - 30 minutes", 4 = "31 - 60 minutes" and 5 = "> 60 minutes"). Sleep latency was then categorized into two groups (≤20 vs >20 minutes per day) based on the Guideline for Sleep Hygiene among Children Aged 0-5 Years, which recommends avoiding sleep latency exceeding 20 minutes per day (34).

Parent-child interaction

Chinese parent child interaction scale (CPCIS) was used to assess the weekly frequency of the following parent child interaction activities in the past month (35, 36): (a) learning

arithmetic/mathematics; (b) English alphabet; (c) Chinese characters; (d) reading; (e) drawing; (f) singing; (g) storytelling; (h) discussing news and current affairs. The scale consisted of 8 items, with each item rated on a 4-point Likert scale ranging from 1 (none) to 4 (4 times or more per week). The items were further computed into two subscale scores: learning activity scores (items a-c) and recreation activity scores (items d-h). A higher score on the scale indicated a more frequent parent child interaction. The validity and reliability of the CPCIS have been demonstrated in previous study (Cronbach's $\alpha = 0.82$) (35).

Family socioeconomic status (Family SES)

Several key family SES indicators were assessed: maternal and paternal education and adjusted family monthly income. These were aggregated into a family SES index using principal component analysis, a validated method to describe family SES differences within a population (37). A higher value in the index indicates a higher SES for the family.

Child's mental health problems

We used the SDQ to assess preschoolers' MHPs, EPs and IPs over the previous six months. SDQ comprises 25 items assessing conduct problems (e.g. fighting, lying, stealing), hyperactivity (e.g. overactive, restless, fidgeting), emotional problems (e.g. worries, unhappiness), peer problems (e.g. solitary, lack of friends), and prosocial behaviour (e.g. kindness, helpfulness). Each item was rated on a 3-point Likert scale, ranging from 0 (not true) to 2 (certainly true). Total difficulty score (range: 0 to 40) were obtained by summing the scores of conduct problems, hyperactivity, emotional and peer problems. The externalising score (range: 0 to 20) was obtained by summing the scores of conduct problems and hyperactivity, while the internalising score (range: 0 to 20)

was obtained by summing the scores of the emotional and peer problems. The higher total difficulty score, externalising score and internalising score reflect higher risk of MHPs, EPs and IPs (38). The total difficulties score higher than 19 was considered as high risk of MHPs, while less than or equal to 18 was considered as low risk of MHPs, which is the cutoff score recommended for the HK population (39). The externalising score and internalising score were dichotomized into low risk (≤ 7 and ≤ 3) and high risk (≥ 8 and ≥ 4) groups, the cutoff score recommended for the United Kingdom (UK) population (40). The SDQ has been widely used in population study in Hong Kong (6, 36). The reliability of the SDQ has been tested by internal consistency (16)**.**

Statistical analysis

All variables were examined for outliers and missing data before analysis. Potential outliers were removed if values ≥ 3 standard deviations from the mean of the variables in this study. Descriptive statistics were utilized to present the means and standard deviations for continuous variables, and the frequencies and percentages for categorical variables. Linear regression analyses were used to assess the relationship between factors and total difficulty score, externalising score as well as internalising score in a set of three models. Model 1 employed univariate linear regression analysis with all factors included individually. Model 2 built upon Model 1 by incorporating adjustments for gender, age, and family SES. Model 3 used multivariate linear stepwise regression analysis with all factors and adjusted for the effects of gender, age, and family SES. The participants were then dichotomized into low- and high-risk groups based on their total difficulty score, externalising score and internalising score. Chi-square tests were conducted to compare the distribution of weekday sleep duration, weekend

sleep duration, sleep latency, educational screen time and entertainment screen time for different groups. Additionally, independent sample t-tests were performed to compare the means and standard deviations of recreation activity scores and learning activity scores across different groups. Multiple logistic regression analyses were used to examine the effect of factors on the risk of total difficulty score, externalising score and internalising score, adjusted for gender, age and family SES. Adjusted odds ratios (aORs) and 95% confidence intervals (CIs) were calculated. The data were analysed using the SPSS version 21.0. and p values <0.05 were considered statistically significant.

RESULTS

Descriptive characteristics

A total of 1926 eligible participants completed questionnaires in this study (Response rate = 78.0%). The sample consisted of 49.1% female participants, with a mean age of 4.39 ± 1.14 years. The participants had an average sleep duration of 9.94 hours and an average screen time of 151.5 minutes (2.53 hours), as indicated in Table 1.

Lifestyle and family environment factors associated with MHPs, EPs and IPs.

Table 2 shows the relationship between lifestyle and family environment factors, and total difficulty score, externalising score and internalising score. The results from the linear regression analyses (Model 3) indicate that both sleep latency (β=0.18, *P*<0.001; β=0.18, *P*<0.001; β=0.11, *P*<0.001;) and entertainment screen time (β=0.06, *P*<0.05; β=0.06, *P*<0.05; β=0.05, *P*<0.05;) were positively associated with all three scores, while recreation activity scores (β=-0.19, *P*<0.001; β=-0.20, *P*<0.001; β=-0.09, *P*<0.001;) exhibited a negative association with all three

scores. The weekday sleep duration (β=-0.05, *P*<0.05) and learning activity scores (β=-0.06, *P*<0.05) were negatively associated with internalising score, but not with externalising score. Educational screen time was positively associated with internalising score (β=0.06, *P*<0.05), but not with externalising score.

Figure 1a to 1c display the results of the logistic regression analyses on the lifestyle and family environment factors affecting the risk of MHPs, EPs and IPs, respectively. After adjusted for covariates (gender, age, and family SES), sleep duration, sleep latency, and recreation activity scores were the significant factors affecting the risk of MHPs (Figure 1a). Specifically, compared to weekend sleep duration ≥ 10hours per day, the risk of MHPs for weekend sleep duration<10hours per day increased by 65% (aOR, 1.65; 95%CI, 1.04-2.62; p<0.05). Compared to sleep latency ≤20 minutes per day, the risk of MHPs for sleep latency >20minutes per day increased by 132% (aOR, 2.32; 95%CI, 1.54-3.49; p<0.001). The risk of MHPs decreased by 19% (aOR, 0.81; 95%CI, 0.74-0.88; p<0.001) with every additional score of recreation activity scores. As shown in Figure 1b, preschoolers with sleep latency >20minutes per day had 1.64 times higher risk of EPs (OR=1.64, 95%CI 1.34-2.00, P<0.001) than those with sleep latency ≤20 minutes per day. The risk of EPs decreased by 10% (aOR, 0.90; 95%CI, 0.87-0.94; p<0.001) with every additional score of recreation activity scores.

As shown in Figure 1c, sleep latency >20minutes per day had 1.35 times (OR=1.35, 95%CI 1.11-1.65, P<0.05) higher risk of IPs than those with sleep latency ≤20minutes per day. Using the educational screen time ≤30minutes per day as the reference, preschoolers' IPs increased by 32% for educational screen time >30minutes per day (aOR, 1.32; 95%CI, 1.03-1.70; p<0.05).

The risk of IPs decreased by 6% (aOR, 0.94; 95%CI, 0.90-0.98; p<0.05) with every additional score of recreation activity scores.

DISCUSSION

Building upon previous evidence on MHPs in children, this study further strengthens the evidence by comprehensively assessing the relationship between lifestyle and family environment factors and MHPs, EPs, and IPs in preschoolers. We found that prolonged sleep latency and excessive entertainment screen time were associated with increased risks of all three types of mental health issues (MHPs, EPs, and IPs), while higher frequency of parent child recreation activities were associated with decreased risks of all three types of mental health issues after adjusting for gender, age, family SES. Notably, excessive educational screen time was associated with an increased risk of IPs, but not EPs. The longer weekday sleep duration and higher frequency of parent child learning activities were associated with a decreased risk of IPs, but not EPs. These findings highlight the differential effects of lifestyle and family environment factors on MHPs, EPs and IPs in preschoolers.

Our findings revealed a positive association between entertainment screen time and sleep latency with MHPs in preschoolers. Conversely, we observed a negative association between weekday sleep duration and parent child recreation activities with MHPs in this age group. Among these factors, parent child recreation activities had the strongest impact on MHPs, followed by sleep latency, entertainment screen time, and weekday sleep duration. There are several possible explanations for these findings. First, prolonged exposure to entertainment content may increase the likelihood of preschoolers imitating inappropriate and violent behaviours (28, 41, 42). It can

also impair attention to low-stimulation tasks such as homework (43), and negatively impact emotional understanding (44) and emotional regulation (45). In addition, the displacement hypothesis suggests that "media use may directly displace time that would otherwise have been used for sleep" (46). Researchers have also found that greater screen use is linked to increased parent reported sleep problems (47). In particular, screen use before bedtime may increase arousal, making it more difficult to initiate sleep (48). Furthermore, screen use has been shown to suppress melatonin production (49), which may contribute to prolonged sleep latency and shortened nighttime sleep duration (50). Second, our findings are consistent with previous research showing that shorter sleep duration and longer sleep latency may be associated with an increased the risk of MHPs (23). Poor sleep, specifically prolonged sleep latency and inadequate sleep duration may impair emotional regulation in children (51) and increase separation anxiety in preschoolers (52), which can be exhibited through externalising behaviours such as attention problems and irritability (20, 53). These findings suggest that improving sleep in preschoolers may reduce the development of both EPs and IPs (54). Finally, our study highlights the important role of parent child recreation activities in reducing the risk of MHPs, potentially offering greater protective value than other lifestyle factors such as sleep and screen time. Parent child interactions are recognized as critical for children's early language development (55), and a positive parent child relationship has also been associated with better sleep in children (56). However, some evidence suggests that screen use not only displaces and distracts from parent child interactions, but also diminishes their quality (57, 58). Importantly, Christakis et al.(58, 59) have identified this disruption as a key mechanism by which screen use may contribute to delays in children's language (60), cognitive (61), and social/emotional development (62, 63).

To gain a more accurate understanding of how lifestyle and family environment factors affect preschoolers' mental health, our study examined EPs and IPs separately. Our findings indicated that excessive educational screen time was associated with IPs, but not with EPs. One possible explanation is that educational programs often require preschoolers to engage in more complex cognitive processes, such as attention, memory, and problem-solving, compared to entertainment programs. These increased perceptual demands may raise mental effort and cognitive load in young children, which in turn influence their emotional regulation (64, 65). Additionally, we observed a negative association between parent child learning activities and IPs, while the association with EPs did not reach statistical significance. These findings further highlight the potential importance of parent child learning interactions in protecting preschoolers from developing IPs. Furthermore, we found few significant associations between weekday sleep duration and EPs, but significant associations with IPs. Although this result contrasts with previous research on the association between parent reported sleep duration and EPs (66, 67), it is consistent with studies using actigraphic measures of sleep duration (68). Future research should focus on the discrepancies in findings that may result from differences in sleep measurement methods, particularly between actigraphy and parent reported assessments. The significant association between sleep duration and IPs may be explained by prior research suggesting that sleep and IPs (particularly anxiety) shared same neural systems and psychobiological processes, such as arousal and vigilance (69). These results provide insight into the development of tailored strategies for preventing EPs and IPs in preschoolers.

To avoid potential non-linear associations between each factor and MHPs, EPs and IPs, logistic regression analyses were conducted separately for MHPs, EPs and IPs. The result indicated that

having a sleep latency of more than 20 minutes per day was associated with a 2.32-fold, 1.64-fold and 1.35-fold increased risk for MHPs, EPs and IPs separately than those with sleep latency of less than 20minutes. Cremone et al. have suggested that prolonged sleep latency may lead toddlers to initiate sleep outside of the optimal circadian phase, limiting the restorative quality of sleep and thereby increasing the risk of negative emotional development (70). This finding reinforces the importance of sleep latency and provides evidence support for the Sleep Hygiene Guideline, which recommends that sleep latency should not exceed 20 minutes (34). Despite this health significance, over 40% of the participants were found to have sleep latency of more than 20 minutes per day. Our study also discovered that educational screen time more than 30 minutes per day had 1.32 times increased risk for IPs than their counterpart. While educational screen programs can serve as a means to support children's developing abilities (71), it is crucial to remain vigilant about their potential risks for IPs. Furthermore, about one- fourth of the participants had a weekend sleep duration of less than 10 hours, which was associated with a 1.65-fold increased risk for MHPs than their counterpart. This finding aligns with previous research indicating that sleep deprivation in preschoolers increases the risk of having more depressive symptoms (23) and symptoms of hyperactivity and impulsivity (72). Sleep deprivation has also been shown to impair the functional connectivity of brain networks in prefrontal regions (73), leading to behavioural and emotional challenges. Recent study by Hoyniak et al. further demonstrated that later sleep during toddlerhood was linked to greater IPs, poorer cognitive and academic function in preschoolers (74).These findings highlight the importance of ensuring preschoolers obtain at least 10 hours of sleep duration to support healthy behavioural and emotional development. Nonetheless, the association between sleep duration and EPs or IPs was not significant. The likely reason for this discrepancy is that we categorized

the total difficulties score from the SDQ into low- and high- risk groups using the HK standard (39). However, owing to the absence of HK-specific cutoffs for the externalising and internalising score, we adopted UK standards (40), which may not be applicable to the HK population. This highlights the need for future studies to develop locally referenced standards for categorizing externalising and internalising score more accurately.

Our study provides valuable for parents, teachers, health care workers and policymakers in preventing mental health issues among preschoolers. First, it is essential to ensure that preschoolers obtain adequate sleep, at least 10 hours per day, and to avoid prolonged sleep latency by keeping it within 20 minutes. In addition, it is important to increase the frequency of parent child recreation and learning activities. We also recommend limiting educational screen time to no more than 30 minutes per day, which is crucial for mitigating the adverse effects associated with excessive screen exposure.

The findings of this study should be interpreted with the following limitations. First, given the cross-sectional design, causal relationships between lifestyle and family environment factors and mental health cannot be established. However, the large school-based sample enhances the generalizability of the findings. Second, all study variables were obtained through parent or guardian report, which may have resulted in recall bias. Moreover, screen time, parent child interactive activities and sleep may not be accurately captured through parent or guardian report alone. Previous research has shown that subjective measures (e.g., self- or parent- report) often diverge from objective measures (e.g., actigraphy) in assessing sleep duration and quality (75). Future research is encouraged to combine both subjective and objective assessment methods for

sleep to improve measurement validity. Third, the study did not account for daytime sleep duration. Though toddlerhood is characterized by substantial developmental changes in sleep patterns, including reduced daytime sleep and progressively consolidated nighttime sleep (76), future studies are needed to determine whether daytime sleep duration is also consequential for mental health in young children.

CONCLUSION

Preschoolers' lifestyle and family environment factors are associated with MHPs, EPs, and IPs respectively. This study underscores the necessity of separately exploring EPs and IPs within the preschool age group. Our findings highlight the importance of adequate sleep duration, avoiding sleep latency exceeding 20 minutes per day, reduce entertainment screen time, limit educational screen time to no more than 30minutes per day, and increase parent child interactive interactions to mitigate preschoolers' mental health issues.

Table 1. Study participant's characteristics in 1926 preschoolers

Variable (range)	N (%) / Mean±SD
Child characteristics	
Gender	
Male	980(50.9)
Female	946(49.1)
Age, y	4.39±1.14
Average sleep duration, h/d	9.94±0.73
Weekday sleep duration, h/d	9.84±0.82
Weekend sleep duration, h/d	10.20±0.79
Sleep latency, min	
≤20	1106(57.4)
>20	820(42.6)
Average screen time, min/d	151.50±108.66
Educational screen time, min/d	17.75±28.17
Entertainment screen time, min/d	133.76±102.02
CPCIS (8-32)	22.55±4.41

Recreation activity scores (5-20)	13.78±2.98
Learning activity scores (3-12)	8.76±2.16
Total difficulty score (0-40)	11.25±4.75
Emotional problems (0-10)	2.11±1.66
Conduct problems (0-10)	2.01±1.40
Hyperactivity (0-10)	4.43±2.10
Peer problems (0-10)	2.70±1.58
Externalising score (0-20)	6.44±3.03
Internalising score (0-20)	4.81±2.65
Prosocial (0-10)	6.75±1.92
Parents characteristics	
Maternal	
Education	
Lower secondary	17(0.9)
Upper secondary	982(51.0)
Postsecondary	923(47.9)
Missing	4(0.2)
Paternal	
Education	
Lower secondary	9(0.5)
Upper secondary	972(50.5)
Postsecondary	937(48.7)
Missing	8(0.4)
Monthly household income ($)	
< 20,000	319(16.6)
20,000 - 39,999	594(30.8)
40,000 – 59,999	490(25.4)
>60,000	523(27.2)
Family SES	0.01±0.88

SD-standard deviation
CPCIS-Chinese parent-child interaction scale
Family SES-Family socioeconomic status

Table 2. Linear regression of factors associated with (a) total difficulty score, (b) externalising score and (c) internalising score.

	Model 1		Model 2		Model 3	
	Beta (95% CI)	*P*	Beta (95% CI)	*P*	Beta (95% CI)	*P*
a. Total difficulty score						
Weekday sleep duration, h/d	-0.07(-0.12, -0.03)	**.001**	-0.08(-0.12, -0.04)	**<.001**	-0.06(-0.10, -0.01)	**.011**
Weekend sleep duration, h/d	-0.06(-0.10, -0.01)	**.015**	-0.06(-0.10, -0.02)	**.007**	NS	
Sleep latency, min	0.19(0.15, 0.23)	**<.001**	0.18(0.14, 0.22)	**<.001**	0.18(0.14, 0.22)	**<.001**
Educational screen time, min/d	0.01(-0.04, 0.05)	.702	0.02(-0.02, 0.07)	.376	NS	
Entertainment screen time, min/d	0.08(0.04, 0.13)	**<.001**	0.09(0.05, 0.14)	**<.001**	0.06(0.01, 0.10)	**.010**
Recreation activity scores	-0.20(-0.25, -0.16)	**<.001**	-0.20(-0.24, -0.15)	**<.001**	-0.19(-0.23, -0.14)	**<.001**
Learning activity scores	-0.14(-0.19, -0.10)	**<.001**	-0.12(-0.17, -0.08)	**<.001**	NS	
b. Externalising score						
Weekday sleep duration, h/d	-0.06(-0.11, -0.02)	**.008**	-0.07(-0.11, -0.02)	**.004**	NS	
Weekend sleep duration, h/d	-0.05(-0.09, -0.001)	**.047**	-0.05(-0.09, -0.01)	**.028**	NS	
Sleep latency, min/d	0.19(0.14, 0.23)	**<.001**	0.18(0.14, 0.23)	**<.001**	0.18(0.14, 0.23)	**<.001**
Educational screen time, min/d	-0.01(-0.05, 0.04)	.759	-0.01(-0.05, 0.04)	.788	NS	
Entertainment screen time, min/d	0.09(0.04, 0.13)	**<.001**	0.08(0.04, 0.13)	**<.001**	0.06(0.01, 0.10)	**.015**
Recreation activity scores	-0.22(-0.26, -0.17)	**<.001**	-0.21(-0.25, -0.16)	**<.001**	-0.20(-0.25, -0.16)	**<.001**
Learning activity scores	-0.12(-0.16, -0.07)	**<.001**	-0.11(-0.15, -0.06)	**<.001**	NS	
c. Internalising score						
Weekday sleep duration, h/d	-0.06(-0.11, -0.02)	**.008**	-0.07(-0.11, -0.02)	**.003**	-0.05(-0.10, -0.01)	**.017**
Weekend sleep duration, h/d	-0.05(-0.09, -0.002)	**.039**	-0.05(-0.10, -0.01)	**.022**	NS	
Sleep latency, min/d	0.13(0.09, 0.17)	**<.001**	0.11(0.07, 0.15)	**<.001**	0.11(0.06, 0.15)	**<.001**
Educational screen time, min/d	0.02(-0.02, 0.07)	.300	0.04(-0.002, 0.09)	.059	0.06(0.02, 0.11)	**.006**
Entertainment screen time, min/d	0.05(0.002, 0.09)	**.041**	0.07(0.02, 0.11)	**.005**	0.05(0.0004, 0.09)	**.048**
Recreation activity scores	-0.11(-0.16, -0.07)	**<.001**	-0.12(-0.16, -0.07)	**<.001**	-0.09(-0.14, -0.04)	**<.001**
Learning activity scores	-0.12(-0.17, -0.08)	**<.001**	-0.10(-0.14, -0.05)	**<.001**	-0.06(-0.11, -0.005)	**.032**

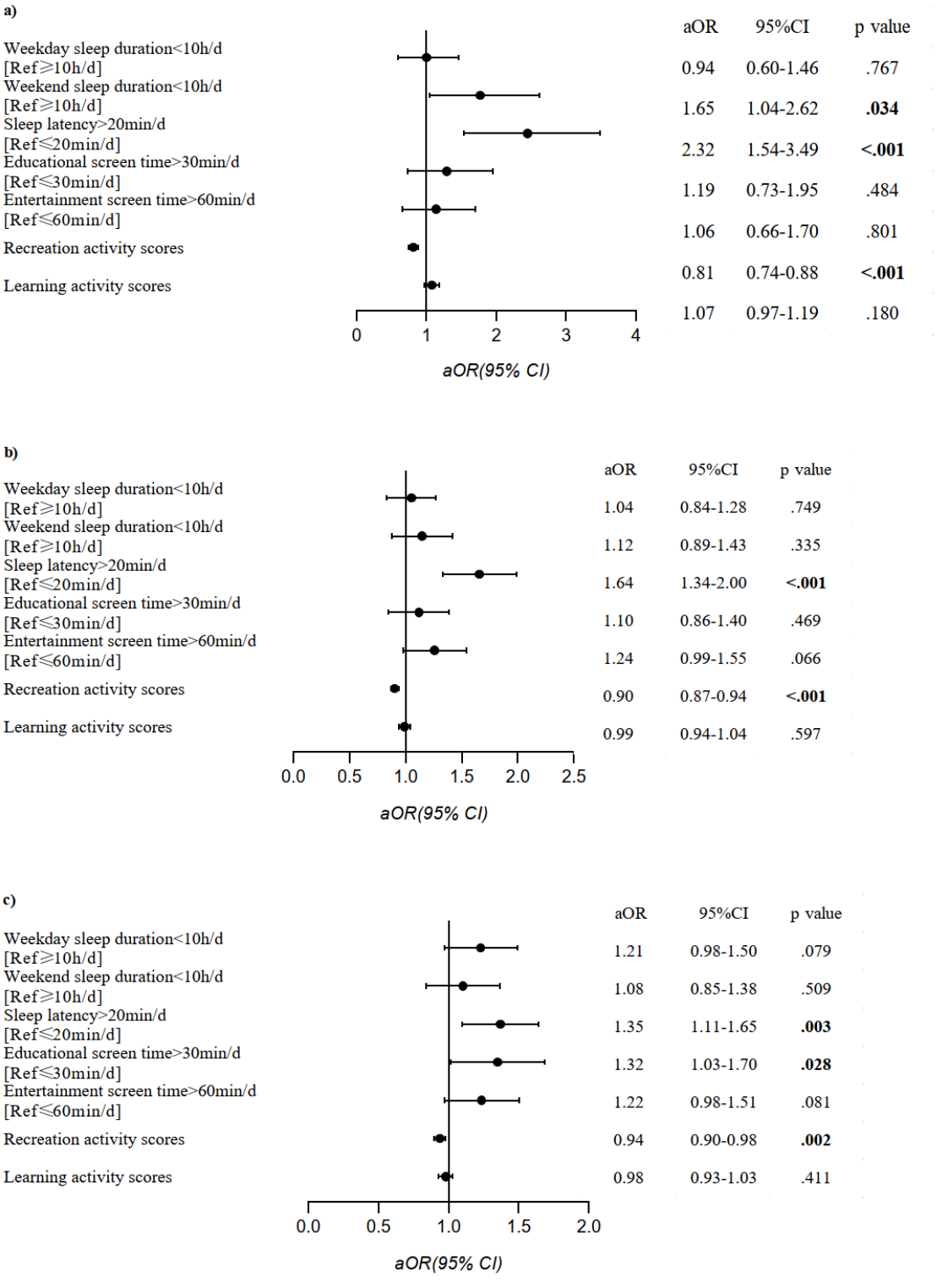
Adjusted for gender, age and family SES in Model 2 and Model 3; Bold: p < 0.05 were considered to have significance; NS: P>0.05.

Table 3. Comparison of characteristics within total difficulty score, externalising score and internalising score groups

Characteristic	N (%) /Mean±SD	Total difficulty score (0-40)		*P*	Externalising score (0-20)		*P*	Internalising score (0-20)		*P*
		Low risk (≤19)	High risk (>19)		Low risk (≤7)	High risk (≥ 8)		Low risk (≤3)	High risk (≥ 4)	
Weekday sleep duration, h/d				.321			.261			**.040**
<10h	936(48.6)	878(93.8)	58(6.2)		606(64.7)	330(35.3)		296(31.6)	640(68.4)	
≥10h	990(51.4)	939(94.8)	51(5.2)		665(67.2)	325(32.8)		357(36.1)	633(63.9)	
Weekend sleep duration, h/d				**.016**			.142			.104
<10h	516(26.8)	476(92.2)	40(7.8)		327(63.4)	189(36.6)		160(31.0)	356(69.0)	
≥10h	1410(73.2)	1341(95.1)	69(4.9)		944(67.0)	466(33.0)		493(35.0)	917(65.0)	
Sleep latency, min/d				**<0.001**			**<0.001**			**<0.001**
≤20	1106(57.4)	1063(96.1)	43(3.9)		780(70.5)	326(29.5)		415(37.5)	691(62.5)	
>20	820(42.6)	754(92.0)	66(8.0)		491(59.9)	329(40.1)		238(29.0)	582(71.0)	
Educational screen time, min/d				.657			.840			.345
≤30	1534(79.6)	1449(94.5)	85(5.5)		1014(66.1)	520(33.9)		528(34.4)	1006(65.6)	
>30	392(20.4)	368(93.9)	24(6.1)		257(65.6)	135(34.4)		125(31.9)	267(68.1)	
Entertainment screen time, min/d				.420			**.023**			.190
≤60	542(28.1)	515(95.0)	27(5.0)		379(69.9)	163(30.1)		196(36.2)	346(63.8)	
>60	1384(71.9)	1302(94.1)	82(5.9)		892(64.5)	492(35.5)		457(33.0)	927(67.0)	
Recreation activity scores	13.78±2.98	13.88±2.96	12.16±2.75	.673	14.11±2.90	13.14±3.03	**<0.001**	14.16±2.99	13.59±2.95	**<0.001**
Learning activity scores	8.76±2.16	8.79±2.16	8.35±2.09	.551	8.90±2.14	8.49±2.17	**<0.001**	9.02±2.13	8.63±2.16	**<0.001**

Bold: p < 0.05 were considered to have significance

Figure1. Multivariate logistic regression of factors associated with the risk of a) MHPs, b) EPs and c) IPs.



Adjusted for gender, age and Family SES;

Ref- Reference, aOR-adjusted odds ratio, CI-confidence interval;
Bold: $p < 0.05$ were considered to have significance

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Keith TS Tung: Conceptualization, Investigation, Writing – Original draft preparation; Xiaoqing Zhang: Conceptualization, Formal analysis, Writing – Original draft preparation; Rosa S Wong: Data curation, Writing – Reviewing and Editing; Hung-Kwan So: Methodology, Project administration; Ka-Man Yip: Data curation, Writing – Reviewing and Editing; Jason CS Yam: Writing – Reviewing and Editing; Sherry KW Chan: Investigation, Writing – Reviewing and Editing; Winnie WY Tso: Validation, Writing – Reviewing and Editing; Patrick Ip: Supervision, Funding acquisition, Writing – Reviewing and Editing.

DECLARATION

Conflict of interest

The authors declare that they have no competing interests.

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Highlights

- Mental health issues can originate in preschool when brain plasticity is highest
- About half of preschoolers had insufficient sleep and long sleep latency
- Excessive screen time for entertainment can raise mental health risks
- Parent-child interaction in learning and recreation can reduce mental health risks