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Interactions between daytime sleep and nighttime sleep at 5 and 17 months: Factors from a representative post-pandemic epidemiological cohort

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ABSTRACT

Objectives: Associations between daytime and nighttime sleep remain poorly documented in early infancy, a developmental period during which sleep patterns are still consolidating. This study aims to (1) examine the prospective associations between daytime and nighttime sleep duration, and (2) identify child, maternal and environmental characteristics associated with daytime and nighttime sleep duration at 17 months of age.

Methods: Maternal reports for 3873 infants from the Quebec Longitudinal Study of Child Development (2021-2023) were collected at 5 months (T1) and 17 months (T2) in a post-pandemic population-based cohort. Cross-lagged regression models were conducted using MPlus; associations with $P < .01$ are reported.

Results: The cross-sectional relations between daytime and nighttime sleep were negative at both T_1 ($P = .01$) and T_2 ($P < .001$). Longer daytime and nighttime sleep at T_1 were both associated with longer nighttime sleep at T_2 ($P < .001$). Longer daytime sleep at T_1 was associated with longer daytime sleep at T_2 ($P < .001$). However, longer nighttime sleep T_1 was not associated with longer daytime sleep at T_2. Higher maternal educational attainment, maternal immigrant status, and being a boy were associated with longer daytime sleep at T_2. A broader set of maternal and environmental factors, such as younger maternal age, maternal immigrant status, higher weekly screen time at T_2, and lower household income were associated with shorter nighttime sleep at T_2.

Conclusions: These results highlight the importance of supporting developmentally appropriate sleep opportunities and addressing contextual factors that may shape early sleep health.

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Introduction

Most research on children's sleep has focused on consolidated nighttime sleep as the primary sleep indicator in early childhood.[1] Nighttime sleep has been examined in relation to biological maturation, parenting practices, and family characteristics. In contrast, daytime sleep represents an important component of young

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What was known

Sleep plays a fundamental role in early child development, and sleep patterns undergo substantial reorganization during infancy as daytime sleep decreases and nighttime sleep becomes more consolidated. Although daytime and nighttime sleep are known to be related, their longitudinal associations during the first 2 years of life and the environmental factors influencing each sleep domain remain poorly understood.

What this study adds

This study provides evidence that daytime sleep at 5 months is associated to both daytime and nighttime sleep duration at 17 months, whereas nighttime sleep is only associated to later nighttime sleep, suggesting distinct developmental pathways for these 2 dimensions of sleep. Findings also highlight the importance of contextual factors, particularly screen exposure and maternal immigrant status, which were associated with longer daytime sleep but shorter nighttime sleep in toddlerhood.

children's 24-hour sleep patterns and has received comparatively less empirical attention.[2-4] During the first 2 years of life, daytime sleep is substantial and plays a crucial role in supporting learning, memory consolidation, and emotional functioning.[2,5] Despite its developmental importance, few longitudinal studies have examined the interaction between daytime and nighttime sleep across infancy, particularly in a post-pandemic cohort.

According to Sadeh and Anders' transactional model,[6] sleep development is rooted in a biopsychosocial framework; that is, infant sleep duration and quality emerge from interactions between biological factors, caregiving environments, and broader sociocultural influences. Recent studies highlight that social and environmental conditions, such as socioeconomic status (e.g., maternal educational attainment), parental characteristics (e.g., maternal age), early childcare settings, and cultural norms, play a substantial role in sleep development in early life.[7-10] Screen time exposure in young children has become a growing concern, as many studies document negative associations between screentime expose and children's sleep.[11-14] Furthermore, the Canadian Paediatric Society (CPS) recommendations emphasized no screen exposure for children under 2 years of age.[15] Similarly, the World Health Organization (WHO) recommends very limited screen exposure under age 5 and warns about potential risks to sleep and health of excessive screentime.[16] However, these recommendations are not often followed by the majority of parents, as Madigan et al[17] documented; on a cohort of more that 1500 children age 2 years of age, the average screen time expose were 2.75 times more likely to exceed recommended screen time guidelines, as no screen time exposure is recommended at this age. Instead of offering digital technologies to children, the CPS recommends around bedtime prioritizing quality child - caregiver interactions and the use of clear sleep-time markers (e.g., known bedtime routine, play calmly in the evening).[15]

Another socio-cultural factor influencing children's sleep is maternal immigrant status. The immigration rate in Canada has significantly raised in the last decade,[18] and it is observed in the health system that immigrant families may require more support and services in relation to child's sleep than non-immigrant families.[19-21] Maternal immigrant status has emerged as a contextual factor influencing infant sleep via multiple mechanisms including cultural norms, environmental constraints, and systemic inequities. Sleep practices among families from diverse cultural backgrounds differ from traditional Western practices; more frequent room or bed sharing, later bedtimes, and different expectations regarding independent sleep are more common in many Asian, Latin American, African, and Middle Eastern cultures.[22,23] For immigrant families, these culturally rooted practices can shape infants' sleep timing and consolidation.[24]

Simultaneously, immigrant mothers may experience heightened psychosocial and structural stressors, such as unstable housing, crowded living environments, irregular or shift-based work schedules, and reduced access to childcare or social support network.[25] These factors have been shown to destabilize bedtime routines and sleep environments, contributing to insufficient or fragmented sleep among young children.[9,10] In relation to screentime exposure, a recent pediatric digital media guideline[15] reported that immigrant families differ in cultural beliefs and environmental constraints surrounding screen use compared to non-immigrant Canadian families. This underscores the importance of examining how these child, maternal and environmental factors could be associated with both daytime and nighttime sleep in early childhood.

Multiple studies have demonstrated that the COVID-19 pandemic transformed the environment in which infants' sleep develops. This included changes in familial routines, closure of childcare centers and/or making adjustments in childcare, decreased in-person contacts and social support, and an increase in the use of media and technologies occurred during the pandemic; there is evidence that some of these changes were maintained after the pandemic ended even after.[25-27] A meta-analysis and systematic review of epidemiological surveys during COVID-19 demonstrate an increased in sleep difficulties among infants and toddlers, including more frequent night waking and prolonged sleep disruptions, which often persisted for months.[28] One study conducted during the pandemic found that screen time of 1 hour or more was an independent risk factor for night waking in a prospective cohort of children followed from birth to 35 months.[29] This finding is particularly relevant and supports the importance of examining how pandemic-related intensified digital media in families with young children may impact sleep.[29] As noted, national organizations have recommend minimizing and modeling screen use with explicit sleep-protective routines (e.g., no screens at least 1 hour before bedtime).[15,29] However, most longitudinal cohorts were initiated before the pandemic and therefore did not capture these societal shifts. We have limited knowledge about how children born and/or raised in the post-COVID context sleep, and how environmental factors such as increased screen exposure, and challenges linked to immigrant family contexts may have shaped early sleep trajectories.[15]

Objectives

The present longitudinal study aimed to disentangle reciprocal associations between sleep dimensions across time, while accounting for multiple contextual correlates, in examining the interactions between daytime and nighttime sleep duration at 5 and 17 months of age in a large, representative population-based pandemic cohort from Quebec (Canada). We aimed to (1) examine the prospective associations between daytime and nighttime sleep duration, while accounting for relevant covariates, and (2) identify child, maternal and environmental characteristics associated with daytime and nighttime sleep duration at 17 months of age.

Method

Procedure and participants

This study is part of the second cohort of Quebec Longitudinal Study of Child Development (QLSCD 2), which is conducted by the Institut de la statistique du Québec. This study was reviewed and approved by the Ethics Committee of the Institut de la statistique du

Québec. Informed consent was obtained from all participating families before their participation. Prior to enrollment, families received information by mail describing the objectives and procedures of the study. This sample is representative of children born in 2020 and 2021 in the province of Quebec, Canada, excluding children living in Cree or Inuit territories, Indian reserves, and northern Quebec. All children were recruited through the Quebec Master Birth Registry, stratified based on living area (15 health and social services regions) and birth rate (for more information on the cohort: https://www.jesuisjeserai.stat.gouv.qc.ca/default_an.htm). Before participating in the study, all families received detailed information by mail on the aims and procedures of the research program and signed a consent form. Families were included if the pregnancy had lasted between 24 and 42 weeks, and the mother could speak French or English. A total of 4703 children participated in the first data collection when they were aged 5 months. The present study analyzed sleep data from 3879 families who were seen when children were 5 months of age (T1) and 17 months of age (T_2); at T1, there were 18 ineligible cases and 806 nonrespondents (i.e., lost to follow-up) (See Table in Supplementary material).

Measures

Sleep variables

Daytime sleep duration was measured by maternal reports at T1 and T2. Parents were asked: "In general, how much time does (child's name) spend sleeping during the daytime?" with an open response option in hours and in minutes. Nighttime sleep duration was also measured by maternal reports at T1 and T2 with the following: "Indicate how long in total your child sleeps during the night (on average). Do not count the hours that your child is awake." Parents reported the number of hours and minutes their child slept at night.

Variables associated with children's sleep

Mothers reported on child, maternal and contextual variables in infancy at T1 (e.g., child's sex, maternal immigrant status, maternal age, maternal education, household income), and at T2 (e.g., child age at daycare entry, mean weekly screen time exposure, maternal depression) in toddlerhood. We chose the following variables as they are known to be associated with both daytime and nighttime sleep[9,16,30-36]; item recoding for analyses is also reported:

- Child's sex – girls/boys;
- Room occupancy rate measured at T1 – number of bedrooms per household member;
- Maternal age (in years) measured at T1;
- Low maternal education at T1 - not having a high school diploma versus having a high school diploma;
- Maternal working status at T2 – yes /no;
- Maternal immigrant status at T1 – yes / no (non-immigrant);
- Household income adequacy at T1 based on 3 indicators: family income, family size, and geographic area using national census data – sufficient/insufficient income;
- Child age at daycare entry measured at T2 – months and days;
- Mean weekly screen time exposure at T2 – minutes;
- Maternal depression at T1 – 1-10 on the Center for Epidemiologic Studies Depression Scale.[37]

Statistical analysis

Cross-lagged multiple linear regression analyses were conducted with MPlus (V8.11) to examine the associations between daytime and nighttime sleep with standardized model coefficients (betas), to represent the strength of the association between the variables over time, while accounting for the following covariates: child's sex, child's age at daycare entry at T2, mean child's weekly screen time exposure at T2, room occupancy rate, maternal age, maternal education, maternal working status at T2, maternal immigrant status, household income, and maternal depression score at T1. The cross-lagged model included the entire set of covariates and was estimated using robust maximum likelihood (MLR), with missing observations handled through full information maximum likelihood (FIML). In accordance with guidelines, overall model fit was assessed using a combination of fit indices, including the Comparative Fit Index (CFI), the Root Mean Square Error of Approximation (RMSEA), the Standardized Root Mean Square Residual (SRMR), and the chi-square to degrees of freedom ratio (χ^2/df). A good model fit is indicated by a CFI value of 0.90 or higher, RMSEA and SRMR values below 0.05, and a χ^2/df ratio lower than 3.[38-40] Longitudinal weights developed by the QLSCD2 study team were also used to maintain sample representativeness from baseline.

Results

Descriptive statistics

The frequencies and means of the study variables are presented in Table 1. For sleeping variables, daytime sleep is on average 3 hours and 17 minutes at 5 months and decreases to 2 hours and 7 minutes at 17 months. For nighttime sleep, infants at T1 sleep on average 10 hours and 8 minutes, which increased by 35 minutes to 10 hours and 43 minutes at T2. Correlations between sleep variables across time points indicated modest continuity in infant sleep patterns, as daytime sleep duration at T1 was positively associated with daytime sleep duration at T2 ($r = .24$, $P < .01$), while nighttime sleep duration demonstrated a somewhat stronger association across time ($r = .33$, $P < .01$).

The sample included similar proportions of girls (48.5%) and boys (51.5%). Average age at daycare entry was 10 months and 21 days. Average weekly screentime at T2 was 43 minutes. At T1, mothers were on average 31.8 years old; 70.4% had at least a high school diploma and 26.2% were immigrants and the mean depressive symptoms scores was

Table 1
Frequencies (%) for categorical variables or means (SD) for continuous variables at 5 and 17 months of age (n = 3879)

Variables	% or M (SD)	Number of missing observations
Outcome variables		
Daytime sleep at 5 mo (Hours Minutes)	3h17 (2h02)	27
Daytime sleep at 17 mo (Hours Minutes)	2h07 (0h31)	832
Nighttime sleep at 5 mo (Hours Minutes)	10h08 (2h32)	21
Nighttime sleep at 17 mo (Hours Minutes)	10h43 (1h17)	830
Independent variables		
Child's sex		0
Girls	51.50%	
Boys	48.50%	
Room occupancy rate	0.86 (0.32)	0
Maternal age (years of age)	31.80 (4.89)	7
Maternal educational status		24
At least high school diploma	70.40%	
No high school diploma	29.60%	
Maternal working status		
Yes	75.45%	
Maternal immigrant status		0
Yes	73.00%	
Household income		
Low	19.70%	
Medium-low	41.40%	
Medium-high	26.00%	
High	13.00%	
Maternal depression at 5 mo, score 0-10	1.73 (0.51)	203
Mean weekly screen time exposure at 17 mo (min)	43 (50)	877
Child age at daycare entry (mo)	10.21 (3.18)	1371

Table 2
Multiple linear regressions to explain daytime sleep duration and nighttime sleep duration at 17 mo (n = 3879)

	β	95% CI lower	95% IC upper	*P*
Daytime sleep at T2 (when the child was aged of 17 mo)				
Daytime sleep at T1	**0.23**	**0.02**	**0.27**	**< .001**
Nighttime sleep at T1	-0.01	-0.04	0.04	.96
Boy, ref = girl	**0.09**	**0.02**	**0.16**	**.01**
Child age at daycare entry	**-0.05**	**-0.09**	**-0.01**	**.02**
Child mean weekly screen time exposure at T2	0.04	0.01	0.09	.07
Maternal age	0.03	-0.01	0.07	.14
Maternal educational status, ref = no high school diploma	**0.09**	**0.04**	**0.13**	**< .001**
Maternal working status at T2, ref = no	0.01	-0.03	0.05	.58
Maternal immigrant status, ref = no	**0.06**	**0.02**	**0.10**	**.01**
Maternal depression score at T1	0.01	-0.03	0.05	.77
Room occupancy rate at T1	-0.01	-0.04	0.03	.87
Household income, ref = sufficient	**0.03**	**0.00**	**0.07**	**.04**
Nighttime sleep at T2 (when the child was aged of 17 mo)				
Daytime sleep at T1	**0.06**	**0.03**	**0.10**	**< .001**
Nighttime sleep at T1	**0.28**	**0.24**	**0.32**	**< .001**
Boy, ref = girl	-0.02	-0.09	0.04	.48
Child age at daycare entry	-0.01	-0.04	0.04	.93
Child mean weekly screen time exposure at T2	**-0.09**	**-0.13**	**-0.05**	**< .001**
Maternal age	**-0.09**	**-0.13**	**-0.05**	**< .001**
Maternal educational status, ref = no high school diploma	-0.02	-0.06	0.02	.29
Maternal working status at T2, ref = no	-0.01	-0.04	0.03	.83
Maternal immigrant status, ref = no	**-0.16**	**-0.19**	**-0.12**	**< .001**
Maternal depression score at T1	-0.03	-0.06	0.01	.12
Room occupancy rate at T1	**0.03**	**0.00**	**0.07**	**.05**
Household income, ref = sufficient	**-0.05**	**-0.08**	**-0.02**	**.01**

Longitudinal sampling weights were applied to the analyses.
Bold values indicate statistically significant associations (p < .05).

1.70. Other sociodemographic variables were the mean room occupancy rate of 0.9, and household income was distributed across low (19.7%), medium-low (41.4%), medium-high (26%), and high (13%) categories. Maternal age is reported in years and should be identified as such in Table 1. Child age is reported in months using a numerical (decimal) format. Accordingly, the average age at daycare entry should be reported as 10.21 months, not as 10 months and 21 days.

Cross-lagged analyses of daytime sleep duration and nighttime sleep duration

There were significant associations for both daytime and nighttime sleep from 5 to 17 months (see Table 2). The cross-sectional relations between daytime and nighttime sleep were negative at both 5 months (β = - 0.06, *P* = .01) and 17 months (β = −0.09, *P* < .001). Longitudinally, daytime sleep at 5 months was positively associated with daytime sleep at 17 months (β = 0.23, 95% CI = 0.02-0.27, *P* < .001), meaning that higher durations of daytime sleep at 5 months were associated with higher durations of daytime sleep at 17 months, while controlling for all covariates. Similarly, nighttime sleep at 5 months was moderately associated with nighttime sleep at 17 months (β = 0.28, 95% CI = 0.24-0.32, *P* < .001); meaning that nighttime sleep showed medium stability over time, such that infants who slept more at night at 5 months tended to also sleep more at night at 17 months.

Fig. 1 shows the cross-lagged multiple linear regression effects between daytime and nighttime sleep. Daytime sleep at 5 months was associated with nighttime sleep at 17 months (β = 0.06, CI = 0.03-0.10, *P* < .001); infants who slept more during the day at 5 months tended to sleep slightly longer at nighttime at 17 months. In contrast, nighttime sleep at 5 months was *not* associated with daytime sleep at 17 months (β = −0.01, 95% CI = −0.04 to 0.04, *P* < .96). The model fit was satisfactory: χ^2 (22) = 24.98, *P* = .30; RMSEA = 0.00, 90% CI (0.001-0.02); CFI = 0.996; TLI = 0.993.

Several contextual factors are associated with daytime sleep at 17 months (see Table 2). Daytime sleep was higher among (a) boys, relative to girls, (β = 0.09, 95% CI = 0.02-0.16, *P* < .001); (b) children whose mothers had high school education or greater (β = 0.09, 95% CI = 0.04-0.13, *P* < .001); (c) children whose mothers were immigrants (β = 0.06, 95% CI = 0.02-0.10, *P* < .01); and (d) children who lived in a family with an insufficient household income (β = 0.03, 95% CI = 0.00-0.07, *P* < .04). Child age at daycare entry was negatively associated with daytime sleep at 17 months (β = −0.05, 95% CI = −0.09 to −0.01, *P* < .02), indicating that children who entered daycare at a younger age slept more during the day at T2. Finally, no significant associations were observed between room occupancy rate, maternal age, maternal depressive symptoms, maternal working status, screen time exposure and daytime sleep at 17 months.

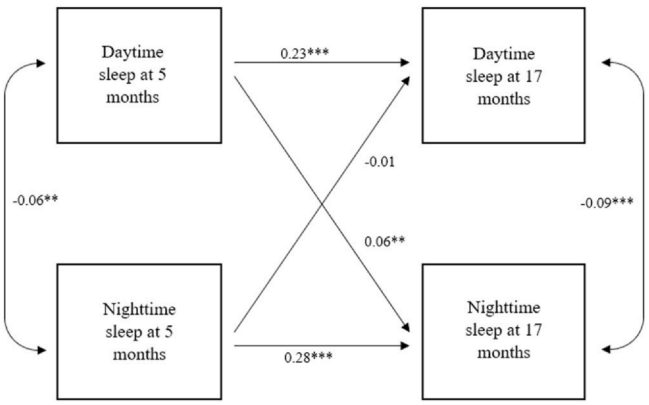


Fig. 1. Cross-lagged associations between daytime sleep and nighttime sleep from 5 to 17 mo, ** < .01; *** < .001

For nighttime sleep at 17 months, greater mean weekly screen time exposure was associated with *shorter* nighttime sleep durations (β = −0.09, 95% CI = −0.13 to −0.05, *P* < .001). Also, insufficient household income (β = −0.05, 95% CI = −0.08 to −0.02, *P* < .01), maternal age (β = −0.09, 95% CI = −0.13 to −0.05, *P* < .001) and maternal immigrant status (β = −0.16, 95% CI = −0.19 to −0.12, *P* < .001) were also negatively associated with nighttime sleep duration at T2, meaning than these covariates are associated with shorter nighttime sleep for toddlers. Higher room occupancy rates at 5 months, were related to longer nighttime sleep at 17 months (β = 0.03, 95% CI =

0.00-0.07, $P < .05$). In contrast, child sex, child age at daycare entry, maternal education, maternal working status and maternal depressive symptoms were not associated with nighttime sleep at 17 months in this model.

Discussion

The present study examined prospective associations between daytime sleep and nighttime sleep from 5 to 17 months, while accounting for key contextual covariates in the second QLSCD cohort. Follow-up data were collected in the post-COVID period (after 2020), a unique socio-historical period that reshaped young children's living conditions, family routines, and digital environments. There are several key findings from this study: (1) there were significant negative associations cross-sectionally between daytime sleep and nighttime sleep at 5 and 17 months, (2) an asymmetric cross-lagged association in which daytime sleep at 5 months was associated with nighttime sleep at 17 months, but not the reverse, and (3) several factors associated with daytime sleep and nighttime sleep at 17 months were identified; for example, higher child weekly screen exposure and maternal immigrant status were both related to longer daytime sleep and shorter nighttime sleep at T2.

First, both daytime sleep and nighttime sleep showed significant continuity from 5 to 17 months, consistent with evidence that sleep organization undergoes rapid developmental changes across infancy. As self-regulatory capacities and circadian rhythms mature across the first 2 years of life, infants' sleep–wake patterns become increasingly organized and predictable.[41] By approximately 3 months of age, many infants begin to exhibit more stable and recognizable consolidated periods of nighttime sleep.[42] Consistent with this developmental process, daytime and nighttime sleep were modestly and negatively associated at both 5 and 17 months, suggesting that infants who slept less during the day tended to sleep slightly longer at night, reflecting an early consolidation of sleep toward the nighttime period. Notably, this study extends previous evidence by documenting the continuity of these sleep patterns within a post-COVID birth cohort, despite concerns that pandemic-related disruptions to family routines and caregiving environments might have altered normative sleep development.[29,43]

An interesting finding of this study was that greater daytime sleep at 5 months was associated to nighttime sleep at 17 months, whereas nighttime sleep at 5 months was not associated with later daytime sleep. This unidirectional association appears consistent with a developmental perspective in which daytime sleep at younger ages supports regulatory maturation and nocturnal sleep consolidation,[44] rather than simply competing with nighttime sleep. Literature suggests that daytime sleep in infancy can support memory consolidation and other neurodevelopmental processes, providing a plausible hypothesis for explaining why longer naps may be facilitate for normative developmental changes in sleep organization.[45,46] At 5 months, daytime sleep is highly malleable and variable, and supports the maturation of circadian and homeostatic systems.[47] There may be a sensitive period during infancy when the quantity (and perhaps quality) of daytime sleep contributes to the development of consolidated nighttime sleep. Therefore, this directional effect would support the importance of preserving developmentally appropriate nap opportunities rather than prematurely reducing daytime sleep to promote nighttime consolidation.

Another important result were the contextual correlates that were associated with infant sleep, highlighting the important interplay between sleep and social environments. At 17 months, higher screen exposure was associated with shorter nighttime sleep and more daytime sleep, suggesting possible compensatory napping among toddlers exposed to more digital media. These results and this interpretation are in concordance with literature demonstrating that nighttime screen usage can impair sleep via routine disturbances, delayed bedtimes and increased difficulties in initiating sleep, and evidence that reducing screen exposure at night can improve sleep in toddlers.[9,36] These results are especially relevant in the post-COVID context, as multiple studies have documented increases in children's screen time during the pandemic, with evidence that elevated screen exposure persists.[48,49] Especially in children, the few studies comparing pre-pandemic to pandemic conditions observed changes in infant sleep timing and consolidation when exposed to an increase in screen exposure; this suggests that pandemic-related shifts in family ecology could be associated with early sleep development.[25,28] Our findings reinforce the importance of the Canadian Paediatric Society and the World Health Organization's public awareness campaigns promoting young children's sleep and later health development impacts.[50,51]

Another important correlate associated with children's sleep was the maternal immigrant status; toddlers of immigrant mothers had longer daytime sleep, but shorter nighttime sleep at 17 months. This result is similar to what is documented in the literature.[9,24,52] Migration-related factors are known to be associated with sleep via multiple potential pathways including adverse housing conditions and household crowding, along with cultural differences in sleep practices.[9] Our results add to the existing literature by highlighting that such cultural patterns may operate differently across daytime and nighttime sleep, particularly in immigrant families navigating the coexistence throughout different cultural norms and structural constraints. Also, our findings may relate to recent literature documenting links between socioeconomic disadvantage, racial/ethnic minority status, and shorter sleep durations among young children, maternal immigrant status may reflect both cultural practices and structural inequities influencing sleep environments.[24,49] Also, a higher room occupancy rate was associated with longer nighttime sleep. Given that higher values indicate a greater number of rooms and therefore more available living space, this finding may suggest that less crowded home environments support longer nighttime sleep duration. Finally, given the social context in Canada where the immigration rate was at its historic high[18] during the time this study was conducted, these finding adds to the existing literature a societal issue that needs to be addressed by public institutions and by the government to help these vulnerable families.

Strengths and limits

This present study includes several strengths. First, the large and representative sample and the longitudinal design are a major strength of this study and allow these results to be generalizable. However, this study also contains several limits to consider. Reliance on maternal report for sleep duration, which may introduce reporting bias, and the observational nature of the design limits causal inference. Unmeasured factors (e.g., bedtime routines, childcare nap policies, infant temperament) may partially account for observed associations. Also, maternal immigrant status was operationalized as a binary variable, which does not capture substantial heterogeneity in the cultural, social, and structural contexts experienced by immigrant families. Consequently, it is not possible to determine which specific mechanisms may underlie the observed association between maternal immigrant status and children's sleep outcomes.

Finally, screen time was assessed as a general measure and did not capture potentially relevant characteristics such as the timing of exposure or the quality and type of content viewed, although these factors may be less critical in a sample of very young children. Furthermore, screen time measures did not distinguish between active and passive exposure, which may have different implications for sleep outcomes. It is also worth noting that screen time was positively skewed, as is commonly observed in young children, and extreme values were winsorized at the 98th percentile prior to analysis to counterpart this bias. Future studies would benefit from

more detailed assessments of screen exposure, including its timing, content, and mode of use, to better understand its relationship with sleep and developmental outcomes.

Conclusion

In summary, the findings suggest that early daytime sleep should not be viewed as inherently detrimental to later nighttime sleep development and reinforce the relevance of modifiable contextual factors, particularly screen exposure, in shaping nighttime sleep during toddlerhood in the post-COVID era and help immigrant families understand why their child sleeps more during the day and less during the night. Importantly, these findings should be interpreted within the context of early infancy, a developmental period during which daytime and nighttime sleep patterns are highly variable and undergoing change and consolidation. As such, longer daytime sleep may reflect variation in overall sleep needs during the establishment of sleep-wake organization, rather than differences in neurodevelopmental maturity, thereby complementing rather than contradicting findings linking earlier nap cessation to more advanced neural maturation later in childhood. Future studies should replicate these results by using objective sleep measures and incorporate not only screen time exposure, but also the exposed content to examine further associations to development skills, such as cognitive and language development.

Author contributions

Dr Fréchette-Boilard drafted the initial manuscript, reviewed and approved the final manuscript as submitted, and agrees to be accountable for all aspects of the work. The first author has full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy. Dre Petitclerc, Dre Côté, Dr Reid, Dr Boivin, and Dre Pennestri reviewed the manuscript for important intellectual content, approved the final manuscript as submitted, and agrees to be accountable for all aspects of the work. Dr Touchette conceptualized the study, carried out the statistical analyses, interpreted the statistical analyses, reviewed and approved the final manuscript as submitted, and agrees to be accountable for all aspects of the work. The last author has full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy.

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Declaration of generative AI and AI-assisted technologies in the writing process

All scientific content, analyses, and interpretations were developed and verified by the authors, who take full responsibility for the manuscript. Generative artificial intelligence tools were used solely for language editing and clarity (e.g., grammar, syntax, or translation).

Data sharing

Data sharing is not permitted, as all data are governed and protected under the legal framework of the Institut de la statistique du Québec.

Declaration of conflicts of interest

G. Fréchette-Boilard, A. Petitclerc, S. Côté, G. Reid, M. Boivin, M.-H. Pennestri, and E. Touchette have no conflict of interest to disclose.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.sleh.2026.09.006.

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