



A cross-sectional, web-based survey on sleep duration and social sleep restriction by daily habits in Japanese children: Cultural considerations

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ABSTRACT

Study objectives: Japanese elementary school children experience short weekday sleep because of academic demands and increasing digital media use. This study examined lifestyle factors associated with children's weekday sleep duration and social sleep restriction (SSR: weekend minus weekday sleep duration) within a sociocultural context.

Methods: Caregivers of 4273 children aged 6–12 years from 125 Japanese schools (response rate: 8.8%) completed online questionnaires between November 2023 and March 2024. Multivariable regression analysis was used to identify correlates, and structural equation modeling (SEM) examined pathways among them. Weekday sleep duration was the primary outcome and SSR was the secondary outcome.

Results: Mean weekday sleep duration was 9 h 16 min (SD = 112 min); SSR was 30 min (SD = 52 min). Female, older age, homework/extracurriculars, pre-bedtime media use, and absent bedtime rules were associated with shorter weekday sleep duration, whereas bedtime reading and outdoor play were associated with longer sleep. Room-sharing, a characteristic of the sleep environment for Japanese children, was also associated with shorter weekday sleep duration. SEM showed the strongest total effect of age ($\beta = -0.389$), followed by pre-bedtime media use ($\beta = -0.194$), and household rules ($\beta = 0.154$) on weekday sleep duration.

Conclusions: Family-based sleep rules, especially media curfews and fixed bedtimes, may help protect weekday sleep duration and reduce SSR among Japanese children despite academic and digital pressures. Findings propose culturally adapted, family-centered interventions for Japanese children's sleep.

1. Introduction

Sleep plays a vital role in maintaining physiological, cognitive, and emotional functioning [1–4]. Despite evidence-based guidelines for age-appropriate sleep durations [5,6], declining sleep durations among children have been reported worldwide [7,8], primarily due to increasingly later bedtimes with unchanged wake times over decades [9].

Insufficient childhood sleep, which manifests as significant social sleep restriction (SSR: weekend minus weekday sleep duration), is prominent during school terms in youth, largely due to weekend catch-up sleep. It is associated with unhealthy dietary behaviors, academic

difficulties, obesity, emotional dysregulation, depressive symptoms and reduced self-esteem [10–12], especially in Asian children [13].

To address these pediatric sleep issues, it is essential to adopt internationally recognized universal sleep principles. The “ABCs of SLEEPING” framework highlights the fundamental pillars of healthy sleep: maintaining age-appropriate consistency in bed- and wake-times, establishing nightly schedules and routines, and restricting the use of electronics before bedtime [14]. Furthermore, contemporary evidence emphasizes that sleep should be managed through an integrated 24-h movement behavior approach [15]. This paradigm focuses on the synergy between adequate sleep, the promotion of outdoor physical activity, and the limitation of sedentary screen time, which together improve

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diverse health indicators. Because children's sleep habits are deeply influenced by the family environment and parental modeling, family-centered interventions are increasingly and globally recognized as a vital strategy for effectively implementing these recommendations [15,16]: a family-wide effort to establish consistent nightly routines is considered a feasible and cost-effective approach. Such routines not only enhance pediatric sleep quality but also contribute to broader developmental outcomes, partly by means of improved family functioning and parent-child attachment [14].

Particularly in Japan, there have been repeated reports of elementary school students getting insufficient sleep; one nationwide study reported an average duration of 9 h 4 min (± 38 min) [17], which sits at the lower end of the recommended 9–11 (or 12) h for this age group [5, 6]. Parents of children with short sleep duration (>1 SD below grade-specific means) often exhibit their own sleep deficits, yet 81% of these parents rate their children's sleep as “good” [17], suggesting that parental underestimation contributes to familial sleep insufficiency. Academic demands, including homework and extracurricular lessons, are primary contributors to sleep loss in school-aged children [18,19]. In Japan, homework begins early in elementary school, and approximately 38% of sixth graders attend supplementary educational institutions after regular school—known as “*juku*” in Japanese—where they study under bright lights until late in the evening [20–22]. In addition, intensified digital media use poses further challenges, especially in the post-COVID-19 era, as household media rules have not kept pace [23]. Another culturally distinctive practice is co-sleeping and/or room sharing, as a nationwide study showed that 74.3% of elementary school-aged children share a room with adults [17]. While international guidelines discourage this practice as hindering autonomy, it remains a deeply rooted Japanese family tradition [24], necessitating culturally sensitive approaches.

While various sleep promotion programs have been evaluated globally, systematic reviews of school-based and behavioral interventions often report inconsistent outcomes, particularly across diverse cultural settings [25,26]. There is a pressing need to move beyond a “one-size-fits-all” approach and instead develop family-centered interventions that are specifically tailored to the unique academic and cultural landscape of Japan.

To address these gaps, this study utilizes a large-scale dataset of Japanese elementary school children during the regular school term. By examining weekday sleep duration and SSR as primary and secondary outcomes, we aim to provide a comprehensive view of sleep patterns and their modifiable determinants. Through thematic regression analyses (simple, within-theme multivariable, fully adjusted) and structural equation modeling (SEM), we identify key lifestyle pathways—including academic burden, bedtime routines, bed arrangements, media use, and household rules—thereby providing evidence-based insights to support healthy sleep within Japan's unique cultural framework.

2. Methods

2.1. Participants and procedure

This cross-sectional study was conducted in Japan from November 2023 to March 2024 among caregivers of elementary school children aged 6–12 years. Data were collected via an online questionnaire administered through a confidential Google-based login system.

Respondents were recruited from 124 public elementary schools and one university-affiliated elementary school during the regular academic term, excluding school holidays. Schools were located in urban and suburban regions in eastern (Tokyo and Nagano) and western Japan (Osaka, Kyoto, Wakayama, Hyogo, Tottori, and Fukuoka). Invitation letters with a survey link were sent to principals of participating schools, who distributed them to caregivers via school-level communication channels (e.g., printed letters or digital systems) outside the holiday

periods before the survey was closed after an adequate response window. Participants, who were recruited voluntarily and anonymously, provided online informed consent prior to completing the survey (estimated completion time <15 min), and no personally identifiable information was collected. Participation incentives included school-level feedback reports and sleep-education materials.

Of 52,611 invited caregivers, 4621 responded (8.8%; range across schools, 4.4%–38.5%). To focus on environmental factors associated with sleep, children with sleep disorders ($n=17$) or neurodevelopmental disorders ($n=262$), epilepsy ($n=26$), chronic physical illness requiring medical treatment ($n=16$), or psychiatric disorders (e.g., depression, anxiety; $n=16$) were excluded (total exclusions, $n=323$ due to overlap). An additional 25 responses were excluded for invalid data (4 with identical responses to all items and 21 with implausible values, such as dinner time after bedtime). The final analytic sample comprised 4273 participants.

This study was conducted in accordance with the Declaration of Helsinki and was approved by the Institutional Review Board of the University of Osaka Hospital (reference number: 23211, 12 September 2023).

2.2. Measures

2.2.1. Questionnaires

The original questionnaire comprised 95 items, including 50 from The Japanese Sleep Questionnaire for Elementary Schoolers (JSQ-ES) [27], 9 from the National Sleep Foundation's *Sleep in America Poll* (2004, 2014) [28,29], 22 original items, and 14 demographic items. Seventeen lifestyle-related items potentially relevant to sleep were selected for analysis (Table S1). The JSQ-ES is a validated instrument for children's sleep habits in Asian contexts [27,30–32]. Items on extracurricular activities were adapted from the 2004 *Sleep in America Poll* [28], those on bedtime routines and media use were adopted from the 2014 version [29]. Additional items assessed weekday screen time; media use within 1 h before bedtime (device type, proximity, and content); unstructured outdoor play (≥ 60 min/day based on 24-Hour Movement Guidelines for Children and Youth) [15]; and bedroom-sharing.

Questionnaire acceptability was confirmed in a pilot with 11 adults.

2.2.2. Variables

Variables included the following lifestyle-related items potentially relevant to sleep and demographic items. Multivariable regression analyses were conducted with unstandardized (B) and standardized (β) coefficients reported for interpretability of both absolute effect sizes and relative contributions. Categorical variables were dummy-coded using reference categories. In the SEM, all independent and dependent variables, including age, were standardized, which is reflected in the β coefficients reported throughout the results. Coding details are provided in Table S1; variable distributions are shown in Table S2.

2.2.2.1. Outcomes and sleep parameters. The primary outcome was weekday sleep duration, calculated as the number of minutes between caregiver-reported weekday bedtime and wake-up time on weekdays (“What time does your child go to sleep/wake up on school days?”), without subtracting sleep onset latency. The secondary outcome was SSR, calculated as weekend sleep duration minus weekday sleep duration in minutes. Social jet lag (SJL) was defined as the difference in midsleep time between weekends and weekdays.

2.2.2.2. Demographics. Child gender (male = 0, female = 1), age (6–12 years), caregiver education (1–5 scale), household income (1,000,000 JPY; midpoint values), residential area (suburban = 0, urban = 1 according to school location) were included in this theme.

2.2.2.3. Activities outside school. Activities outside school included

weekday homework time (minutes; using range midpoint), number of extracurricular activities per week (0–7), and unstructured outdoor play frequency (0 = never to 8 = daily).

2.2.2.4. Bedtime routines and sleeping arrangements. Frequency of reading and other quiet pre-bedtime activities without using media devices (e.g., drawing, building blocks; 1 = never to 4 = often) and sleeping arrangement (solitary [reference], room-sharing with siblings, or room-sharing with adults, including mixed sibling-adult arrangements) were assessed.

2.2.2.5. Media use. Weekday screen time (0–390 min, midpoints). Media use within 1 h before bedtime (TV viewing, non-TV video viewing, video games, digital messaging, computer use or web-surfing) as well as media device usage in the bedroom (TV, computer, tablet/smartphone, calls with phone, video game, music player) were coded from 1 (never) to 4 (most or all nights).

2.2.2.6. Household rules. Fixed bedtime, daily screentime limits, device-specific curfews (TV, smartphone, computer/tablet, video games), and media content restrictions were assessed. For regression, these were dummy-coded with compliance as reference (non-compliance = 1, no rules = 1, no device use = 1; see [Table S1](#)).

2.3. Statistical analysis

Descriptive statistics and Pearson correlations were computed for sleep parameters ([Tables 2 and 3](#)). Analyses proceeded in two stages: (1) multivariable regression analyses identifying lifestyle correlates of weekday sleep duration and SSR, followed by (2) SEM examining structural relationships among these factors.

2.3.1. Regression analyses

Multivariable linear regressions were conducted for both outcomes

Table 1
Sample characteristics.

Variables	n (%)
	mean ± SD
Total	4273 (100.0)
Child age(years)	9.3 ± 1.8
Child gender	
Male	2143 (50.2)
Female	2018 (47.2)
Other/Prefer not to disclose	112 (2.6)
Child ethnicity	
Japanese	4238 (99.2)
Other	20 (0.5)
Prefer not to disclose	15 (0.3)
Caregiver's educational level	
Junior high school	53 (1.2)
High school	651 (15.2)
Vocational/tech school	780 (18.3)
College/university	2472 (57.9)
Advanced degree	219 (5.1)
Blank/doesn't want to say	98 (2.3)
Annual household income	
<3,000,000 JPY (20,000 USD)	184 (4.3)
<5,000,000 JPY (33,333 USD)	515 (12.1)
<10,000,000 JPY (66,666 USD)	1873 (43.8)
<15,000,000 JPY (100,000 USD)	665 (15.6)
≥15,000,000 JPY (100,000 USD)	167 (3.9)
Blank/doesn't want to say	869 (20.3)
Residence	
Urban area (city population ≥100,000)	3636 (85.1)
Suburban area (city population <100,000)	637 (14.9)

Abbreviations: SD, standard deviation; JPY, Japanese Yen; USD, United States Dollar.

Note: 1 USD was approximately 150 JPY as of March 2024.

Table 2
Descriptive statistics of sleep parameters.

Variables	Mean ± SD
Weekday sleep duration (h)	9.28 ± 1.87
Weekend sleep duration (h)	10.30 ± 3.96
Weekday wake-up time (hh:mm)	06:37 a.m. ± 00:27
Weekend wake-up time (hh:mm)	07:34 a.m. ± 01:01
Weekday bedtime (hh:mm)	09:29 p.m. ± 00:44
Weekend bedtime (hh:mm)	09:58 p.m. ± 00:54
Social jet lag (min)	42.9 ± 35.2
Social sleep restriction (min)	29.63 ± 51.92

Abbreviations: SD, standard deviation; CI, confidence interval.

Table 3
Correlations between sleep parameters.

Variable pairs	r	95% CI
Weekend sleep duration (vs. weekday sleep duration)	0.38***	[0.35, 0.40]
Weekend wake-up time (vs. weekday wake-up time)	0.51***	[0.48, 0.53]
Weekend bedtime (vs. weekday bedtime)	0.81***	[0.80, 0.82]
Social jet lag (vs. weekday sleep duration)	-0.25***	[-0.28, -0.22]
Social sleep restriction (vs. weekday sleep duration)	-0.41***	[-0.43, -0.38]

Note: r = Pearson's correlation coefficient; CI, confidence interval.

***p < 0.001.

(minutes) in three steps ([Tables 4 and 5](#)): Step 1, crude (unadjusted) models; Step 2, theme-specific models (demographics, after-school activities, bedtime routines/sleeping arrangements, media use, household rules); Step 3, fully adjusted models (variance inflation factor [VIF] < 5 for multicollinearity). Bonferroni-adjusted $\alpha = 0.025$ was applied for two primary outcomes to all multiple regression analyses ([Tables 4–5, S3–S4](#)). Age-stratified analyses (6–9 vs. 10–12 years; lower vs. upper elementary grades) were also conducted ([Tables S3–S4](#)) to account for developmental shifts, including puberty onset, increased academic burden, and greater media autonomy.

2.3.2. Structural equation modeling

Based on the results of regression analyses and theoretical considerations, variables were grouped into construct variables for SEM (see [Table S1](#) for differences in variable handling versus regression analyses). Confirmatory factor analysis was used to evaluate measurement structure and latent variables. SEM estimated paths from predictors (with age and gender covaried) to correlated outcomes (weekday sleep duration and SSR); ([Fig. 1](#) and [Table 6, S5](#)). Fit indices were interpreted using root mean square error of approximation (RMSEA) ≤ 0.06, comparative fit index (CFI)/Tucker-Lewis index (TLI) ≥ 0.95, and root mean square residual (SRMR) ≤ 0.08 [[33](#)]; models with CFI/TLI ≥ 0.90 were considered acceptable.

2.3.3. Software

Descriptive statistics and regression analyses used *JMP Student Edition*, version 19 (SAS Institute, Cary, NC); SEM used *Mplus*, version 9 (Muthén & Muthén, Los Angeles, CA).

3. Results

3.1. Sample characteristics

[Table 1](#) details the participant characteristics. The mean age of the children was 9.3 ± 1.8 years (range: 6–12), comprising 2143 males (50.2 %), 2018 females (47.2 %), and 112 with missing/unspecified gender (2.6%). Notably, 99.2% of children (n = 4238) were of Japanese ethnicity. For caregivers, 96.5 % of respondents had a high school education or higher. The most common household income range was 5,000,000–10,000,000 Japanese yen (≈33,333–66,666 USD as of March 2024, when the data were collected). Additionally, 85.1% of the

Table 4
Results of univariate and multivariable regression analyses of weekday sleep duration (minutes).

Themes/Independent variables	Step 1: Univariate (crude)			Step 2: Multivariable (theme-specific)			Step 3: Multivariable (fully adjusted)			
	B	95% CI	β	B	95% CI	β	B	95% CI	β	VIF
Intercept (Step3)							644.29***	[630.20, 658.39]		
Demographics										
Intercept (Step2)				620.69***	[611.85, 629.53]					
Child's gender (male = 0, female = 1)	-3.49**	[-5.94, -1.04]	-0.04	-3.62**	[-6.15, -1.08]	-0.04	-3.35**	[-5.82, -0.87]	-0.04	1.12
Child's age (6-12)	-8.89***	[-9.52, -8.26]	-0.39	-8.90***	[-9.61, -8.18]	-0.39	-6.22***	[-7.01, -5.43]	-0.27	1.43
Caregiver's educational level (1-5)	3.06***	[1.64, 4.48]	0.07	2.60***	[1.07, 4.14]	0.06	0.53	[-0.94, 1.99]	0.01	1.18
Household income (1,000,000 JPY)	0.30	[-0.13, 0.72]	0.02	0.21	[-0.21, 0.62]	0.02	-0.06	[-0.45, 0.33]	-0.01	1.16
Residence (suburban = 0, urban = 1)	-1.12	[-4.52, 2.28]	-0.01	-0.08	[-3.67, 3.51]	-0.00	1.67	[-1.67, 5.02]	0.01	1.02
Activities outside school										
Intercept (Step 2)				553.99***	[550.80, 557.18]					
Weekday homework (min)	-0.19***	[-0.24, -0.14]	-0.12	-0.19***	[-0.24, -0.15]	-0.12	-0.10***	[-0.14, -0.05]	-0.06	1.05
Extracurricular activities (1-8)	-4.12***	[-4.78, -3.46]	-0.18	-4.05***	[-4.70, -3.40]	-0.18	-2.74***	[-3.43, -2.05]	-0.12	1.13
Outdoor play frequency (1-9)	2.04***	[1.50, 2.59]	0.11	1.84***	[1.30, 2.37]	0.10	0.89**	[0.34, 1.43]	0.05	1.08
Bedtime routines and Sleeping arrangements										
Intercept (Step 2)				521.12***	[516.93, 525.31]					
Reading (1-4)	7.74***	[6.73, 8.74]	0.23	6.97***	[5.92, 8.02]	0.20	1.42**	[0.28, 2.55]	0.04	1.29
Quiet activities (1-4)	5.45***	[4.03, 6.87]	0.11	2.75***	[1.31, 4.19]	0.06	0.59	[-0.88, 2.07]	0.01	1.11
Room-sharing with siblings (reference = solitary sleep)	-1.28	[-5.50, 2.95]	-0.01	7.85**	[2.61, 13.09]	0.06	-0.28	[-5.59, 5.03]	-0.00	1.69
Room-sharing with adults (reference = solitary sleep)	7.56***	[4.57, 10.56]	0.08	8.33***	[4.58, 12.07]	0.08	-5.78**	[-9.74, -1.83]	-0.06	1.84
Media use										
Intercept (Step 2)				593.42***	[585.52, 601.31]					
Weekday screentime (min)	-0.13***	[-0.15, -0.11]	-0.22	-0.10***	[-0.12, -0.08]	-0.17	-0.08***	[-0.10, -0.06]	-0.13	1.29
Media use within 1 h before bedtime										
TV (1-4)	-0.31	[-1.32, 0.71]	-0.01	1.22*	[0.23, 2.21]	0.04	1.02	[-0.02, 2.07]	0.03	1.13
Non-TV video (1-4)	-7.46***	[-8.38, -6.53]	-0.24	-4.28***	[-5.34, -3.22]	-0.14	-2.36***	[-3.53, -1.20]	-0.07	1.60
Gaming on any device (1-4)	-4.81***	[-5.83, -3.79]	-0.14	0.27	[-0.86, 1.40]	0.01	-0.53	[-1.79, 0.72]	-0.02	1.59
Digital messaging (1-4)	-8.86***	[-10.70, -7.01]	-0.14	-2.62**	[-4.54, -0.70]	-0.04	2.01	[-0.05, 4.07]	0.03	1.28
Computer use or surfing (1-4)	-8.20***	[-9.98, -6.42]	-0.14	-3.04**	[-4.89, -1.20]	-0.05	-2.34*	[-4.25, -0.42]	-0.04	1.23
Media device usage in the bedroom										
TV (1-4)	-8.96***	[-11.81, -6.10]	-0.09	-1.42	[-4.40, 1.55]	-0.01	-2.39	[-5.42, 0.64]	-0.03	1.26
Computer (1-4)	-14.57***	[-19.42, -9.72]	-0.09	-0.32	[-5.41, 4.78]	-0.00	0.10	[-5.00, 5.20]	0.00	1.25
Tablet or smartphone (1-4)	-12.99***	[-14.62, -11.35]	-0.23	-6.42***	[-8.34, -4.50]	-0.11	-3.53***	[-5.51, -1.56]	-0.06	1.55
Calls with phone (1-4)	-22.32***	[-27.89, -16.75]	-0.12	-7.50*	[-13.27, -1.73]	-0.04	-6.08	[-11.76, -0.39]	-0.03	1.24
Video game (1-4)	-13.73***	[-17.14, -10.33]	-0.12	-1.54	[-5.20, 2.12]	-0.01	-1.19	[-4.91, 2.53]	-0.01	1.32
Music player (1-4)	-13.51***	[-17.91, -9.12]	-0.09	-1.54	[-6.08, 2.99]	-0.01	-1.46	[-6.26, 3.35]	-0.01	1.20
Household rules										
Intercept (Step 2)				551.85***	[549.81, 553.89]					
Fixed bedtime (reference = compliance)										
Non-compliance	-28.57***	[-32.59, -24.56]	-0.21	-25.55***	[-30.01, -21.10]	-0.19	-17.28***	[-21.98, -12.58]	-0.12	1.38
No rules	-21.89***	[-25.63, -18.15]	-0.17	-21.77***	[-25.77, -17.78]	-0.17	-14.30***	[-18.40, -10.20]	-0.11	1.28
Daily screentime limit (reference = compliance)										
Non-compliance	-12.13***	[-15.26, -9.00]	-0.12	-4.56	[-8.63, -0.49]	-0.04	-0.36	[-4.64, 3.92]	-0.00	1.95

(continued on next page)

Table 4 (continued)

Themes/Independent variables	Step 1: Univariate (crude)			Step 2: Multivariable (theme-specific)			Step 3: Multivariable (fully adjusted)			
	B	95% CI	β	B	95% CI	β	B	95% CI	β	VIF
No rules	-3.54**	[-6.14, -0.94]	-0.04	-2.77	[-6.05, 0.51]	-0.03	0.41	[-3.00, 3.81]	0.00	1.85
No device usage	6.47	[-0.21, 13.15]	0.03	-1.61	[-8.69, 5.47]	-0.01	-0.98	[-8.48, 6.53]	-0.00	1.25
TV curfew (reference = compliance)										
Non-compliance	-15.65***	[-19.60, -11.70]	-0.12	-2.75	[-7.78, 2.28]	-0.02	-3.00	[-8.20, 2.21]	-0.02	1.84
No rules	-10.45***	[-13.07, -7.82]	-0.12	-9.60***	[-12.99, -6.21]	-0.11	-5.41**	[-8.95, -1.87]	-0.06	1.92
No device usage	-8.30	[-16.97, 0.37]	-0.03	-18.30***	[-26.94, -9.65]	-0.06	-12.24**	[-21.21, -3.27]	-0.04	1.17
Smartphone curfew (reference = compliance)										
Non-compliance	-21.66***	[-25.78, -17.54]	-0.16	-4.53	[-10.57, 1.50]	-0.03	0.56	[-5.73, 6.85]	0.00	2.42
No rules	-4.97***	[-7.91, -2.03]	-0.05	5.32	[0.55, 10.09]	0.05	2.32	[-2.63, 7.27]	0.02	3.12
No device usage	11.93***	[9.20, 14.66]	0.13	7.73***	[4.22, 11.23]	0.08	2.67	[-0.99, 6.34]	0.03	1.88
Computer/tablet curfew (reference = compliance)										
Non-compliance	-18.70***	[-23.03, -14.38]	-0.13	1.30	[-5.11, 7.72]	0.01	2.63	[-4.02, 9.28]	0.02	2.54
No rules	-4.94***	[-7.76, -2.12]	-0.05	1.26	[-3.45, 5.98]	0.01	-2.09	[-6.98, 2.81]	-0.02	3.25
No device usage	8.45***	[5.42, 11.47]	0.08	3.53	[-0.33, 7.39]	0.03	-0.61	[-4.65, 3.43]	-0.01	1.84
Videogame curfew (reference = compliance)										
Non-compliance	-19.78***	[-23.87, -15.69]	-0.14	-4.33	[-10.08, 1.41]	-0.03	-3.64	[-9.72, 2.44]	-0.03	2.23
No rules	-6.16***	[-9.22, -3.09]	-0.06	0.88	[-3.50, 5.27]	0.01	0.48	[-4.02, 4.98]	0.00	2.35
No device usage	9.25***	[5.72, 12.78]	0.08	4.38	[0.34, 8.42]	0.04	-1.75	[-6.11, 2.61]	-0.01	1.61
Media content restriction (reference = compliance)										
Non-compliance	-14.70***	[-19.04, -10.36]	-0.10	1.30	[-4.03, 6.64]	0.01	2.16	[-3.36, 7.67]	0.01	1.71
No rules	-2.93	[-5.58, -0.28]	-0.03	3.18	[-0.29, 6.65]	0.04	1.08	[-2.44, 4.59]	0.01	1.91
No device usage	6.41***	[3.33, 9.49]	0.06	1.89	[-1.97, 5.75]	0.02	2.13	[-1.85, 6.10]	0.02	1.72

Abbreviations: β , standardized coefficient beta; CI, confidence interval.

* $p < 0.025$ (Bonferroni corrected for 2 outcomes: weekday sleep duration and social sleep restriction), ** $p < 0.01$, *** $p < 0.001$.

Note: Step 1 examined each independent variable separately using univariate regression models.

Step 2 conducted multivariable regression models within thematic groups of variables.

Step 3 included all independent variables simultaneously in a multivariable regression model.

participants lived in urban areas.

Regarding sleeping arrangements, 95.9% of younger children and 80.6% of older children shared a bedroom with someone. Overall, 11.4% of children slept alone in their own rooms. Among those who shared a bedroom with others, 47.1% used separate bedding, while 41.5% shared bedding with others. Furthermore, among children who shared a bedroom (including those who shared bedding), 79.6% slept in the same room as their parents or other adults (Table S2).

3.2. Sleep parameters

Table 2 presents descriptive statistics of sleep parameters. The mean weekday sleep duration was 9.28 ± 1.87 h, and the mean weekend sleep duration was 10.30 ± 3.96 h. Variability (SD) in sleep timing was smallest for weekday wake time (27 min), followed by weekday bedtime (44 min), weekend bedtime (54 min), and weekend wake time (61 min). The mean SJL and SSR were 42.9 ± 35.2 min and 29.6 ± 51.9 min, respectively.

Table 3 shows significant correlations among sleep parameters. Weekday sleep duration was positively correlated with weekend sleep duration ($r = 0.38$, $p < 0.001$) and negatively correlated with SJL ($r = -0.25$, $p < 0.001$) and SSR ($r = -0.41$, $p < 0.001$). Weekday and weekend wake-up times were moderately correlated ($r = 0.51$, $p < 0.001$), and weekday and weekend bedtimes were strongly correlated ($r = 0.81$, $p < 0.001$).

3.3. Multivariable regression analyses

We conducted the univariate and multivariable regression analyses of weekday sleep duration and SSR in three steps: crude, theme-specific, and fully adjusted models (Tables 4 and 5). Coefficients for some variables changed substantially across steps, and confounding with other

variables was confirmed (e.g., the coefficients for “quiet activities” in the category of Bedtime routines and Sleeping arrangements were 5.45, 2.75, and 0.59 in Steps 1, 2, and 3, respectively, and were no longer significant in Step 3; Table 4). No multicollinearity was observed in Step 3 models (all VIFs < 5 ; Tables 4 and 5). Accordingly, we primarily report the findings from the fully adjusted Step 3 models.

In the Step 3 model with weekday sleep duration (Table 4) and SSR (Table 5), after controlling for confounding factors, girls had significantly shorter sleep duration ($B = -3.35$, $p = 0.008$), and longer SSR ($B = 18.02$, $p < 0.001$) than boys, while older age was associated with shorter sleep duration ($B = -6.22$, $p < 0.001$) and longer SSR ($B = 3.35$, $p < 0.001$). None of the sociodemographic variables—caregiver’s educational level, household income, or residence—was significantly associated with any sleep outcomes.

With weekday homework and extracurricular activities were negatively associated with weekday sleep duration ($B = -0.10$, $p < 0.001$; $B = -2.74$, $p < 0.001$), whereas outdoor play frequency was positively ($B = 0.89$, $p = 0.001$) correlated with it in Step 3. Weekday homework was significantly positively correlated with SSR ($B = 0.11$, $p < 0.001$).

Bedtime routine reading was associated positively with weekday sleep duration ($B = 1.42$, $p = 0.014$) and negatively associated with SSR ($B = -2.06$, $p = 0.011$). Room-sharing with adults was negatively associated with weekday sleep duration ($B = -5.78$, $p = 0.004$) but unrelated to SSR. Subgroup analyses on room-sharing with siblings/adults showed negative associations with weekday sleep duration among younger children ($B = -13.30$, $p = 0.007$; $B = -15.51$, $p < 0.001$) (Table S3), as well as that with SSR among older children ($B = -14.6$, $p < 0.003$; $B = -7.97$, $p = 0.025$) (Table S4).

Weekday screentime was negatively correlated with weekday sleep duration ($B = -0.08$, $p < 0.001$); however, no significant association was observed with SSR ($B = 0.02$, $p = 0.203$) in Step 3. Among media types used before bedtime, non-TV video (e.g., tablets, smartphones, or

Table 5
Results of univariate and multivariable regression analyses of social sleep restriction (minutes).

Themes/Independent variables	Step 1: Univariate (crude)			Step 2: Multivariable (theme-specific)			Step 3: Multivariable (fully adjusted)			
	B	95% CI	β	B	95% CI	β	B	95% CI	β	VIF
Intercept (Step 3)							-12.92	[-32.61, 6.77]		
Demographics										
Intercept (Step 2)				-30.67***	[-42.31, -19.02]					
Child's gender (male = 0, female = 1)	20.69***	[17.62, 23.76]	0.20	20.43***	[17.10, 23.77]	0.20	18.02***	[14.56, 21.48]	0.18	1.12
Child's age (6-12)	5.32***	[4.45, 6.19]	0.18	5.42***	[4.47, 6.36]	0.19	3.35***	[2.25, 4.45]	0.12	1.43
Caregiver's educational level (1-5)	-1.19	[-3.03, 0.64]	-0.02	-0.35	[-2.36, 1.67]	-0.01	0.60	[-1.45, 2.65]	0.01	1.18
Household income (1,000,000 JPY)	-0.14	[-0.68, 0.40]	-0.01	-0.09	[-0.64, 0.45]	-0.01	0.10	[-0.45, 0.65]	0.01	1.16
Residence (suburban = 0, urban = 1)	4.77	[0.40, 9.14]	0.03	4.43	[-0.30, 9.15]	0.03	3.98	[-0.70, 8.65]	0.03	1.02
Activities outside school										
Intercept (step 2)				27.44***	[23.24, 31.63]					
Weekday homework (min)	0.20***	[0.14, 0.26]	0.10	0.20***	[0.14, 0.26]	0.10	0.11***	[0.05, 0.18]	0.06	1.05
Extracurricular activities (1-8)	1.54***	[0.67, 2.40]	0.05	1.47***	[0.61, 2.32]	0.05	0.61	[-0.36, 1.57]	0.02	1.13
Outdoor play frequency (1-9)	-2.11***	[-2.81, -1.41]	-0.09	-1.99***	[-2.69, -1.29]	-0.08	-0.78	[-1.54, -0.02]	-0.03	1.08
Bedtime routines and sleeping arrangements										
Intercept (Step 2)				54.60***	[49.11, 60.09]					
Reading (1-4)	-4.92***	[-6.24, -3.60]	-0.11	-4.20***	[-5.57, -2.82]	-0.09	-2.06*	[-3.64, -0.48]	-0.05	1.29
Quiet activities (1-4)	-3.69***	[-5.53, -1.85]	-0.06	-1.94	[-3.83, -0.05]	-0.03	-1.03	[-3.09, 1.03]	-0.02	1.11
Room-sharing with siblings (reference = solitary sleep)	-3.70	[-9.14, 1.74]	-0.02	-17.63***	[-24.50, -10.75]	-0.10	-10.60**	[-18.01, -3.18]	-0.06	1.69
Room-sharing with adults (reference = solitary sleep)	-8.52***	[-12.37, -4.66]	-0.07	-14.66***	[-19.57, -9.75]	-0.11	-3.38	[-8.90, 2.15]	-0.03	1.84
Media use										
Intercept (Step 2)				8.34	[-2.28, 18.97]					
Weekday screentime (min)	0.04***	[0.02, 0.06]	0.05	0.03**	[0.01, 0.06]	0.04	0.02	[-0.01, 0.04]	0.02	1.29
Media use within 1 h before bedtime										
TV (1-4)	-1.72**	[-3.03, -0.41]	-0.04	-1.87**	[-3.20, -0.54]	-0.04	-1.40	[-2.86, 0.07]	-0.03	1.13
Non-TV video (1-4)	3.14***	[1.93, 4.36]	0.08	1.90**	[0.47, 3.33]	0.05	-0.48	[-2.11, 1.14]	-0.01	1.60
Gaming on any device (1-4)	-0.61	[-1.94, 0.71]	-0.01	-3.80***	[-5.32, -2.27]	-0.09	-1.27	[-3.03, 0.48]	-0.03	1.59
Digital messaging (1-4)	8.01***	[5.63, 10.40]	0.10	5.12***	[2.53, 7.71]	0.06	1.07	[-1.81, 3.94]	0.01	1.28
Computer use or surfing (1-4)	6.90***	[4.60, 9.20]	0.09	4.28***	[1.79, 6.77]	0.06	3.99**	[1.31, 6.66]	0.05	1.23
Media device usage in the bedroom										
TV (1-4)	2.64	[-1.05, 6.33]	0.02	-2.72	[-6.73, 1.29]	-0.02	-1.25	[-5.48, 2.98]	-0.01	1.26
Computer (1-4)	13.30***	[7.04, 19.56]	0.06	4.98	[-1.88, 11.84]	0.02	3.49	[-3.64, 10.61]	0.02	1.25
Tablet or smartphone (1-4)	9.02***	[6.88, 11.17]	0.13	6.02***	[3.43, 8.61]	0.08	3.89**	[1.13, 6.65]	0.06	1.55
Calls with phone (1-4)	10.23**	[3.03, 17.45]	0.04	-2.86	[-10.64, 4.91]	-0.01	-6.29	[-14.24, 1.65]	-0.03	1.24
Video game (1-4)	7.76***	[3.36, 12.17]	0.05	2.01	[-2.91, 6.94]	0.01	-0.46	[-5.65, 4.74]	-0.00	1.32
Music player (1-4)	12.54***	[6.87, 18.20]	0.07	5.15	[-0.95, 11.26]	0.03	1.41	[-5.31, 8.12]	0.01	1.20
Household rules										
Intercept (Step 2)				27.19***	[24.46, 29.92]					
Fixed bedtime (reference = compliance)										
Non-compliance	22.07***	[16.84, 27.31]	0.13	21.09***	[15.13, 27.06]	0.12	14.55***	[7.98, 21.11]	0.08	1.38
No rules	14.93***	[10.06, 19.80]	0.09	16.67***	[11.32, 22.02]	0.10	16.11***	[10.38, 21.84]	0.10	1.28
Daily screentime limit (reference = compliance)										
Non-compliance	6.43**	[2.38, 10.49]	0.05	1.18	[-4.27, 6.63]	0.01	-0.19	[-6.16, 5.79]	-0.00	1.95
No rules	1.29	[-2.06, 4.64]	0.01	2.20	[-2.20, 6.59]	0.02	0.33	[-4.43, 5.09]	0.00	1.85
No device usage	3.68	[-4.92, 12.29]	0.01	4.48	[-5.01, 13.96]	0.02	9.29	[-1.20, 19.77]	0.03	1.25
TV curfew (reference = compliance)										

(continued on next page)

Table 5 (continued)

Themes/Independent variables	Step 1: Univariate (crude)			Step 2: Multivariable (theme-specific)			Step 3: Multivariable (fully adjusted)			
	B	95% CI	β	B	95% CI	β	B	95% CI	β	VIF
Non-compliance	10.79***	[5.68, 15.90]	0.06	1.22	[-5.51, 7.96]	0.01	3.01	[-4.27, 10.28]	0.02	1.84
No rules	4.80**	[1.40, 8.20]	0.04	4.53	[-0.00, 9.07]	0.04	0.13	[-4.81, 5.08]	0.00	1.92
No device usage	17.07**	[5.92, 28.21]	0.05	19.27**	[7.69, 30.84]	0.05	11.25	[-1.28, 23.78]	0.03	1.17
Smartphone curfew (reference = compliance)										
Non-compliance	16.73***	[11.38, 22.07]	0.09	6.30	[-1.79, 14.38]	0.04	4.30	[-4.49, 13.09]	0.02	2.42
No rules	0.61	[-3.18, 4.39]	0.00	-4.54	[-10.93, 1.85]	-0.04	1.46	[-5.46, 8.38]	0.01	3.12
No device usage	-7.43***	[-10.96, -3.89]	-0.06	-7.93***	[-12.63, -3.23]	-0.07	-2.80	[-7.92, 2.32]	-0.02	1.88
Computer/tablet curfew (reference = compliance)										
Non-compliance	14.04***	[8.45, 19.63]	0.08	2.98	[-5.61, 11.57]	0.02	0.23	[-9.06, 9.53]	0.00	2.54
No rules	0.24	[-3.39, 3.87]	0.00	-2.29	[-8.60, 4.02]	-0.02	-2.28	[-9.12, 4.56]	-0.02	3.25
No device usage	-2.99	[-6.90, 0.92]	-0.02	-1.74	[-6.91, 3.43]	-0.01	-1.79	[-7.44, 3.85]	-0.01	1.84
Videogame curfew (reference = compliance)										
Non-compliance	9.74***	[4.43, 15.06]	0.05	-4.20	[-11.90, 3.49]	-0.02	-3.86	[-12.36, 4.64]	-0.02	2.23
No rules	2.72	[-1.23, 6.66]	0.02	2.04	[-3.83, 7.91]	0.02	1.35	[-4.93, 7.64]	0.01	2.35
No device usage	0.75	[-3.81, 5.31]	0.00	3.36	[-2.05, 8.78]	0.02	1.68	[-4.42, 7.77]	0.01	1.61
Media content restriction (reference = compliance)										
Non-compliance	10.10***	[4.50, 15.71]	0.05	-0.59	[-7.74, 6.55]	-0.00	0.41	[-7.29, 8.11]	0.00	1.71
No rules	-1.37	[-4.78, 2.04]	-0.01	-5.09	[-9.73, -0.44]	-0.04	-3.20	[-8.11, 1.70]	-0.03	1.91
No device usage	-1.26	[-5.23, 2.71]	-0.01	-1.05	[-6.21, 4.12]	-0.01	1.81	[-3.74, 7.36]	0.01	1.72

Abbreviations: β, standardized coefficient beta; CI, confidence interval.

*p < 0.025 (Bonferroni corrected for 2 outcomes: weekday sleep duration and social sleep restriction), **p < 0.01, ***p < 0.001.

Note: Social sleep restriction = weekend sleep duration – weekday sleep duration (min).

Step 1 examined each independent variable separately using univariate regression models.

Step 2 conducted multivariable regression models within thematic groups of variables.

Step 3 included all independent variables simultaneously in a multivariable regression model.

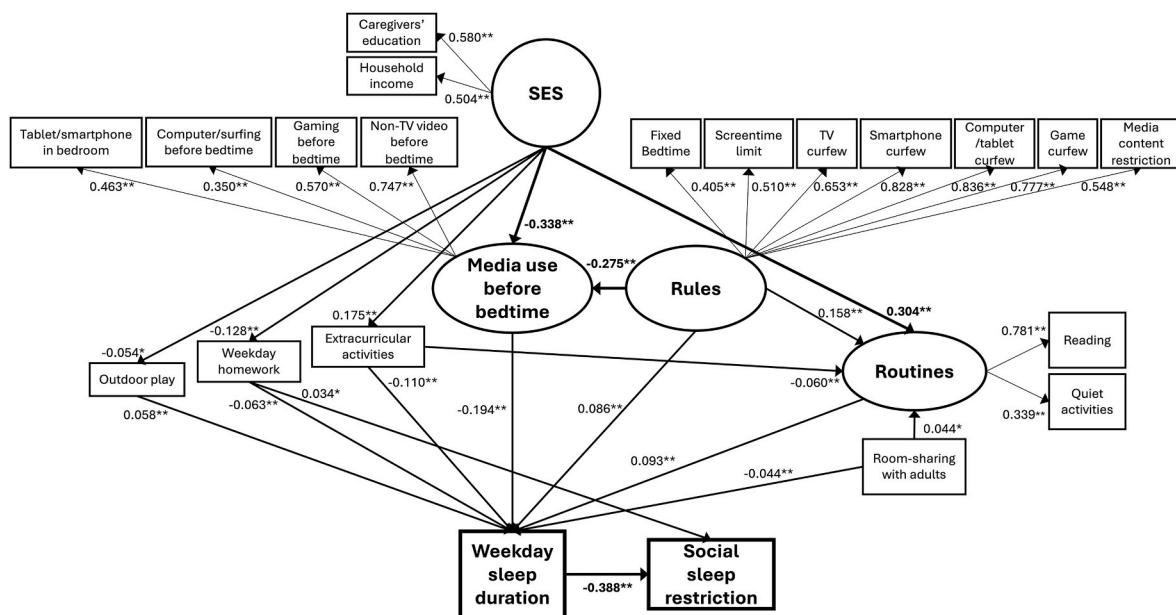


Fig. 1. Path diagram of pre-bedtime habits' effects on weekday sleep duration and social sleep restriction. The path diagram illustrates the effects of pre-bedtime habits on sleep duration and social sleep restriction (SSR). Model fit indices: comparative fit index (CFI) = 0.937, Tucker–Lewis index (TLI) = 0.916, root mean square error of approximation (RMSEA) = 0.038, standardized root mean square residual (SRMR) = 0.034. Cutoff values RMSEA ≤ 0.06, CFI and TLI ≥ 0.95, and SRMR ≤ 0.08 were chosen with reference to Hu and Bentler (1999), although a slightly more lenient criterion (CFI/TLI ≥ 0.90) was adopted in the present study. Solid arrows represent significant structural paths (p < 0.05*, p < 0.01**). Thin lines indicate small effects (β < 0.20), and thick lines indicate moderate or larger effects (β ≥ 0.20). Age and gender were included as covariates for all variables except SES and are omitted from the figure for visual simplicity. Non-significant paths are not shown. Full details of the estimated paths are provided in.

computers) within 1 h before bedtime was significantly negatively associated with sleep duration (B = -2.36, p < 0.001). The use of tablets and smartphones in the bedroom was negatively associated with sleep duration and positively associated with SSR (B = -3.53, p < 0.001;

B = 3.89, p = 0.006). These associations were stronger among older children (B = -3.65, p = 0.010; B = 4.99, p = 0.015) (Tables S3 and S4). Although computer use and Internet surfing within 1 h before bedtime were associated negatively with sleep duration and positively with SSR

Table 6
Standardized total, direct, and indirect effects on sleep duration and social sleep restriction in structural equation modeling.

Predictors	Weekday sleep duration			Social sleep restriction		
	Total	Direct	Indirect	Total	Direct	Indirect
Age	-0.389***	-0.263***	-0.125***	0.182***	0.020	0.162***
Gender (male = 0, female = 1)	-0.049***	-0.050***	-0.000	0.204***	0.176***	0.027***
SES	0.082***	–	0.082***	-0.034***	–	-0.036***
Routines	0.093***	0.093***	–	-0.064**	-0.028	-0.036***
Rules	0.154***	0.086***	0.068***	-0.055**	-0.001	-0.054***
Media use before bedtime	-0.194***	-0.194***	–	0.039	-0.036	0.075***
Extracurricular activities	-0.116***	-0.110***	-0.006*	0.030	-0.016	0.047***
Weekday homework	-0.061***	-0.063***	0.001	0.057**	0.034*	0.023***
Outdoor play	0.058***	0.058***	–	-0.045**	-0.023	-0.022***
Room-sharing with adults	-0.040**	-0.044**	0.004	-0.007	-0.021	0.014*
Weekday sleep duration	–	–	–	-0.388***	-0.388***	–

Note: The values represent standardized coefficients (STDYX). Total effects are decomposed into direct and indirect components. Indirect effects denote the sum of all specific indirect effects and the total indirect effects through all mediators. For social sleep restriction, indirect effects represent all paths via weekday sleep duration and other mediators. All models were adjusted for age and gender across all variables; SES (socioeconomic status) was not controlled for by age or gender, and SES was not specified as having a direct path to the outcomes.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

($B = -2.34$, $p = 0.017$; $B = 3.99$, $p = 0.004$), no such associations were observed among younger children.

Regarding compliance with household rules, both non-compliance and absence of a fixed bedtime were negatively associated with sleep duration ($B = -17.28$, $p < 0.001$; $B = -14.30$, $p < 0.001$) and positively associated with SSR ($B = 14.55$, $p < 0.001$; $B = 16.11$, $p < 0.001$). For the television curfew, the absence of rules and the lack of television usage were negatively correlated with sleep duration ($B = -5.41$, $p = 0.003$; $B = -12.24$, $p = 0.008$); neither was associated with SSR.

3.4. SEM of daily habits and sleep duration/SSR

The SEM included four latent variables: socioeconomic status (SES), media use before bedtime, rules, and routines. SES was conceptualized as influencing lifestyle factors and was not specified to have direct paths to weekday sleep duration or SSR. Although some variables that did not form valid latent constructs in the CFA were theoretically meaningful, they were included in the model as endogenous observed variables. The model assumed weekday sleep duration and SSR as outcome variables, with an additional path from weekday sleep duration to SSR. Adjustments were made for age and gender across all latent factors (except SES), endogenous observed variables, and outcomes. The path diagram is presented in Fig. 1. Standardized total, direct, and indirect effects of the model are shown in Table 6, and all standardized direct effects are summarized in Table S5. The model fit indices indicated an acceptable fit to the data: RMSEA = 0.038, CFI = 0.937, TLI = 0.916, and SRMR = 0.034.

The standardized path coefficient from weekday sleep duration to SSR was $\beta = -0.388$ ($p < 0.001$), indicating a moderate negative association. All latent and endogenous observed variables showed direct associations with weekday sleep duration and were indirectly associated with SSR through weekday sleep duration (Table 6). In terms of total effects (combining direct and indirect effects), age showed the strongest association with weekday sleep duration ($\beta = -0.389$, $p < 0.001$). Among lifestyle-related factors, media use before bedtime ($\beta = -0.194$, $p < 0.001$), rules ($\beta = 0.154$, $p < 0.001$), and extracurricular activities ($\beta = -0.116$, $p < 0.001$) were most strongly associated. Regarding SSR, weekday sleep duration showed the largest association ($\beta = -0.388$, $p < 0.001$), followed by gender (male = 0, female = 1; $\beta = 0.204$, $p < 0.001$), age ($\beta = 0.182$, $p < 0.001$), routines ($\beta = -0.064$, $p = 0.003$), weekday homework ($\beta = 0.057$, $p = 0.001$), and rules ($\beta = -0.055$, $p = 0.001$) (Fig. 1 and Table 6). Outdoor play showed a positive association with weekday sleep duration ($\beta = 0.058$, $p < 0.001$) and a negative association with SSR ($\beta = -0.045$, $p = 0.004$). Room-sharing with adults demonstrated a weak negative association with weekday sleep duration ($\beta = -0.040$, $p = 0.009$), but no clear

association with SSR. SES demonstrated significant indirect positive effects on weekday sleep duration ($\beta = 0.082$, $p < 0.001$) and negative effects on SSR ($\beta = -0.034$, $p < 0.001$) (Table 6). Higher SES was associated with reduced pre-bedtime media use ($\beta = -0.338$, $p < 0.001$) and homework time ($\beta = -0.128$, $p < 0.001$), increased bedtime routine ($\beta = 0.304$, $p < 0.001$), and greater extracurricular activity participation ($\beta = 0.175$, $p < 0.001$), but reduced outdoor playtime ($\beta = -0.054$, $p = 0.023$). No associations were found with rules or room-sharing (Table S5).

4. Discussion

To our knowledge, this is the first study in Japanese elementary school children to examine how daily lifestyle habits and household rules relate to both weekday sleep duration and SSR, accounting for catch-up compensation. Our SEM demonstrated that media use before bedtime showed the strongest negative association with weekday sleep duration and a small indirect positive association with SSR, while household rules were positively associated with sleep duration and weakly negatively associated with SSR through restricting media behaviors and enforcing consistent bedtimes.

4.1. Sleep duration and demographic patterns

Mean weekday sleep duration was only slightly above the National Sleep Foundation's minimum recommendation for this age group [5]. The prevalence of short sleep (<9 h) among all children was 31.7% on weekdays and 13.4% on weekends, with SSR (≥ 2 h) prevalence of 6.6%. Older children and girls exhibited shorter weekday sleep duration and longer SSR than younger children and boys, aligning with prior studies [34,35]. Weekday wake time variability remained low, reflecting fixed school schedules [36]. Consequently, variability of weekday sleep duration primarily reflects that of bedtime. Weekend wake times exhibited greater variability, indicating compensatory sleep without external constraints.

4.2. Extracurricular activities and routines

SES showed direct positive associations with bedtime routine consistency but was also positively correlated with extracurricular activities, which negatively impact both sleep duration and routine quality. Consistent with prior research reporting that parental educational aspirations show no direct correlation with sleep duration among elementary school children but negatively affect sleep duration through extracurricular activities—particularly cram school (*juku*) attendance—among junior high school students [37], our findings

suggest similar mechanisms may be emerging in this elementary school population.

Both extracurricular activities and weekday homework time negatively correlated with weekday sleep duration. A prior Japanese study reported 56.7 min/day homework time among grade 4–6 children, increasing to 70.3 min/day with *juku* attendance [20]. Notably, 73.6% and 55.1% of older and younger children participated in activities ending after 6:00 p.m., which our SEM analyses linked to poorer bedtime routines.

Outdoor play—which showed positive associations with weekday sleep duration and aligns with prior evidence linking it to improved child health and sleep [38–40]—was negatively associated with SES, potentially reflecting academic burden displacing playtime in higher-SES families prioritizing *juku* attendance. Notably, 16.9% and 8.3% of older and younger children, respectively, reported no outdoor playtime.

Bedtime reading was also positively associated with weekday sleep duration, consistent with previous findings [28,41].

4.3. Cultural context of room-sharing

Room-sharing is nearly universal among Japanese elementary children (95.9% younger, 80.6% older), reflecting established cultural norms [17]. Our SEM revealed no association with SES ($\beta = 0.002$, $p = 0.937$) and only a weak negative association with weekday sleep duration overall. Age-stratified regression analyses revealed distinct patterns: among younger children, room-sharing with adults associated negatively with weekday sleep duration but not with SSR, whereas among older children, no weekday association emerged and SSR showed a negative correlation. It is thought that younger children synchronize with adults' sleep due to co-sleeping, resulting in a shorter sleep duration on weekdays as they require longer sleep than adults [42]. In contrast, while older children approach adult sleep patterns, room-sharing may continue to act as a regulatory factor. Furthermore, room-sharing is suggested to prevent older children from waking up significantly later on weekends. Because children's sleep end times on weekends remain closely associated with those of their parents in shared sleeping environments [42], the extension of weekend sleep is potentially limited. This suppression of weekend "catch-up sleep" may explain why their SSR does not increase significantly despite potential sleep restriction during the week.

While frequent co-sleeping has been linked to sleep problems in young children in the United States, reports from Japan suggest that there is no such association, indicating that cultural factors may account for this difference [43]. Our current findings also suggest that the impact of room-sharing itself is limited among school-aged children compared to other lifestyle factors, which may be attributed to long-standing cultural or genetic norms [44]. However, the fact that the elementary school children in this study obtained less sleep than the recommended duration suggests that room-sharing may still exert a subtle but significant influence on sleep quantity. Further investigation is needed to determine the extent to which this cultural practice contributes to chronic sleep restriction in the Japanese pediatric population.

4.4. Digital media and rules

Since 2021, under the Ministry of Education's Global and Innovation Gateway for All (GIGA) school initiative, Japanese schools have provided one tablet per student nationwide. Concurrently, 36.2%, 24.2%, and 9.0% of grade 4–6 children already own personal smartphones, tablets, and computers, respectively [20]. In our study, such interactive portable media use before bedtime showed the strongest negative association with weekday sleep duration, unlike passive TV viewing, which was consistent with prior studies [45–47]. This disparity likely reflects both greater interactivity and closer proximity (20–30 cm vs. 2–3 m), resulting in substantially greater blue light exposure.

Paradoxically, Step 3 regression revealed that the absence of TV use was associated with shorter sleep duration (Table 4), likely reflecting substitution with unregulated other portable devices [48]. Targeted restrictions on interactive media thus appear essential. Given their necessities for educational technologies, fostering healthy digital citizenship in this age group presents both opportunities and challenges for their long-term health.

Our SEM revealed that household rules effectively controlled media use, demonstrating positive correlation with weekday sleep duration overall and negative correlations with SSR. Multivariable regression analyses further indicate that, beyond media regulation, establishing fixed bedtimes is highly effective—a finding consistent with reports from other countries [26,49]. Interestingly, SES showed no significant association with rule-setting ($\beta = 0.028$, $p = 0.269$; Table S5). Amid prevalent dual-income households, maintaining consistent family rules may challenge all socioeconomic strata.

4.5. Implications

These findings highlight household rules—particularly media curfews and fixed bedtimes—as key modifiable targets for sleep promotion. Daily habit factors delay children's bedtimes, curtailing weekday sleep and exacerbating SSR. Given growing recognition that short sleep duration and prolonged SSR harm child well-being, intervention opportunities exist to promote sleep consistency. Amid global movements toward SNS restrictions for minors—including Australia's 16-and-under ban, France's under-15 prohibition, and emerging European age-verification mandates—household-level media curfews emerge as a scientifically supported complement. Societal efforts should support caregivers, alleviate child-rearing burdens, and advocate for children's sleep rights, while cautioning against excessive academic pressures and encouraging unstructured outdoor play.

4.6. Limitation

First, caregiver-reported sleep duration may overestimate actual sleep compared to objective measures, as subjective reports often reflect time in bed rather than physiological sleep duration. This discrepancy is often attributed to the difficulty caregivers face in distinguishing physiological sleep from quiet wakefulness in bed [50]. Prior evidence indicates that while parent-reported and actigraphy-based measures show good agreement for sleep timing, differences emerge when considering actual sleep duration, accounting for sleep onset latency [51]. In our study, sleep duration was defined as the interval between reported bedtime and wake-up time (essentially time in bed); therefore, the impact of this specific reporting bias on sleep timing may be less pronounced. Furthermore, 79.6% of children in our sample shared a bedroom with adults—caregivers likely had frequent opportunities to observe sleep-wake transitions relatively well. Nevertheless, some degree of measurement error cannot be excluded.

Second, the 8.8% response rate with school-level rates ranging from 4.4% to 38.5% raises selection bias concerns; however, prior survey methodology evidence indicates that web-based surveys without direct incentives can yield low response rates; for example, a population-based study reported a 3.4% response rate in a no-incentive condition [52]. This supports the view that an 8.8% response rate is not unusual for a voluntary, online survey without direct incentive to caregivers. We also confirmed that maternal education, household income, and sleep patterns were consistent with national data [20,53,54]. Nevertheless, health-conscious caregivers may have been overrepresented, potentially underestimating the study results.

Third, the cross-sectional design precludes causal inference.

Future studies should employ objective measures, longitudinal designs to establish causality, and cross-cultural comparisons to contextualize Japan-specific patterns.

5. Conclusions

Our findings underscore that children's sleep must be contextualized within sociocultural frameworks, where societal norms prioritize academic achievement over sleep health amid rising digital device access in Japan. Household rules—particularly media curfews and fixed bedtimes—emerge as key modifiable targets. These results suggest that family-centered interventions are warranted in Japan to promote children's sleep health.

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CRedit authorship contribution statement

Kanako Kawamura: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Resources, Software, Validation, Visualization, Writing – original draft, Writing – review & editing. **Tomoko Nishimura:** Methodology, Software, Validation. **Masako Taniike:** Conceptualization, Resources, Supervision, Validation, Writing – review & editing. **Ikuko Mohri:** Conceptualization, Methodology, Project administration, Resources, Supervision, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix B. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.sleep.2026.109054>.

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