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Original Article

Geocultural differences in preschooler sleep profiles and family practices: an analysis of pooled data from 37 countries

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Abstract

Study Objectives: To examine (1) multidimensional sleep profiles in preschoolers (3–6 years) across geocultural regions and (2) differences in sleep characteristics and family practices between Majority World regions (Pacific Islands, Sub-Saharan Africa, Eastern Europe, Northeast Asia, Southeast Asia, South Asia, the Middle East and North Africa, and Latin America) and the Minority World (the Western world).

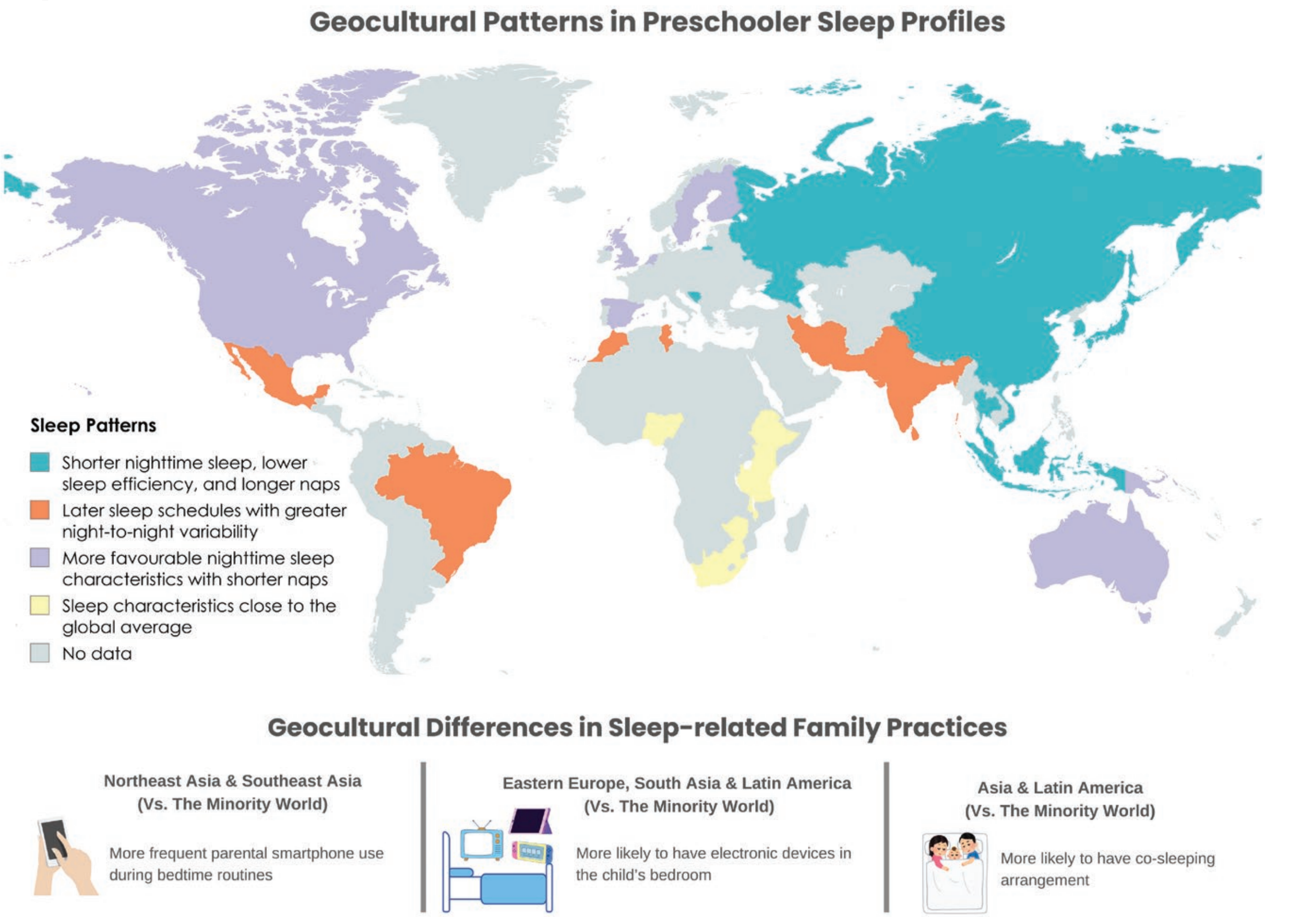
Methods: Participants were 3507 preschoolers from 37 countries. Nighttime sleep characteristics and nap duration (accelerometer: $n = 1950$) and family practices (parental questionnaire) were measured. Mixed models were used to estimate the marginal means of sleep characteristics by region and examine the differences.

Results: Geocultural region explained up to 30% of variance in sleep characteristics. A pattern of short nighttime sleep duration, low sleep efficiency, and long nap duration was observed in Eastern Europe, Northeast Asia, and Southeast Asia. The second pattern, with later sleep midpoints and greater night-to-night sleep variability, was observed in South Asia, the Middle East and North Africa, and Latin America. Compared to the Minority World, less optimal sleep characteristics were observed in several Majority World regions, with medium-to-large effect sizes ($|d|$=0.48–2.35). Several Majority World regions reported more frequent parental smartphone use during bedtime routines (Northeast Asia, Southeast Asia: 0.77–0.99 units) and were more likely to have electronic devices in children's bedroom (Eastern Europe, Latin America, South Asia: OR = 5.97–16.57) and co-sleeping arrangement (Asia, Latin America: OR = 7.05–49.86), compared to the Minority World.

Conclusions: Preschoolers' sleep profiles and related family practices vary across geocultural regions, which should be considered in sleep health promotion initiatives and policies.

Key words: behavioral sleep; public health; early childhood; cross-cultural comparison

Graphical Abstract



Statement of Significance

Existing evidence on preschoolers' sleep mainly focuses on a single dimension—duration—and is largely drawn from the Minority World, or traditionally the Western world, highlighting the need for a more comprehensive and inclusive understanding of sleep. Our study found that preschoolers' sleep profiles varied across geocultural regions globally, independent of country income levels, urbanicity, parental education, and child age. There were notable disparities in child sleep characteristics and family practices between the Majority World and the Minority World. Our findings underscore the importance to estimate the health impact of these disparities, address gaps in sleep recommendations, and develop tailored sleep health promotion strategies in early childhood.

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The widespread high prevalence of suboptimal sleep has led to an urgent call to prioritize sleep health as a part of the global public health agenda [1]. Young children are especially vulnerable, with poor sleep impacting brain development, physical growth, and long-term health and learning [2]. Our understanding of early childhood sleep is predominantly based on data from the Minority World, or traditionally "Western" world [3]. In systematic reviews examining the health implications and correlates of sleep in the early years, over 75% of studies were conducted in the United States, Canada, Australia, New Zealand, or Western European countries [4, 5]. However, these countries represent only 7% of the global population of young children [6]. This underrepresentation of the Majority World biases our understanding of sleep in this age group, as sleep patterns may vary across geocultural contexts. Understanding this contextual influence on child sleep and related family practices (e.g. bedtime routines, sleep arrangement, bedroom environments) is important to inform global sleep health interventions, guidelines, and policies [7].

To our knowledge, no study has examined geocultural differences in young children's sleep and related family practices on a global scale [1, 7]. A meta-analysis of subjectively measured sleep in children under three found differences between Asian countries and the Minority World countries[1] [8]. For preschool aged children (3–6 years), only one known study has examined cross-cultural sleep differences, also comparing Asian countries and the Minority World countries[2] [9]. There is a lack of data from the Majority World beyond Asia, such as Latin America, Eastern Europe, the Middle East, and Africa. Even within Asia, it is unclear whether child sleep profiles differ across subregions—Northeast, Southeast, and South Asia—given the cultural heterogeneity [10].

Existing cross-cultural studies have relied on parental reports of child sleep, which are prone to social desirability bias, issues with recall ability, and awareness of daytime sleep (i.e. naps) while under the care of others, such as early childhood education and care (ECEC) services [11]. While such studies provided some insights into cross-cultural differences in sleep duration and bedtime in young children, there is a lack of evidence on other dimensions, such as sleep continuity (e.g. sleep efficiency) and variability (i.e. night-to-night variability in sleep duration, timing, and efficiency). These dimensions are less likely to be accurately captured by subjective measures [11], underscoring the need for device-based measures to provide a more objective, comprehensive understanding.

The primary objectives of this study were to (1) examine device-based multidimensional sleep profiles, including nighttime sleep characteristics and nap duration, in preschoolers across geocultural regions and (2) compare nighttime sleep characteristics, nap duration, and total sleep duration of each Majority World region with the Minority World. A secondary objective was to examine the differences in family practices between each Majority World region and the Minority World.

Materials and Methods

Study design and participants

This study analyzed data from the International Study of Movement Behaviors in the Early Years (SUNRISE) pilot study [12], which includes countries from major geocultural regions globally. A detailed description of the SUNRISE study can be found elsewhere [12]. Each country recruited approximately 100 sex-balanced preschoolers from both urban and rural communities using convenience clustering sampling, either through ECEC services or community recruitment.

There were three phases of data collection due to progressive modifications of certain measures (e.g. motor skills) to better capture relevant data and to improve study protocols for global use. Modification in measures specific to this study were for secondary outcomes (family practices), detailed in Materials and Methods. Phase I commenced in March 2017, involving seven countries. Phase II took place from January 2018 to December 2019 with 12 countries. Phase III began in February 2020 and is currently ongoing (18 additional countries). This study included data from countries that completed collection by December 2023 (Supplementary Table S1). A total of 3769 families from 37 countries consented to participation. Of these, 71 children were ineligible due to age (<3 years), resulting in 3698 eligible participants. Ethical approval was obtained from the University of Wollongong, Australia (2018/044) and related ethics committee in each participating country.

Measures

Sleep.

Sleep was measured in all phases using waist-worn Actigraph GT3X + accelerometers (ActiGraph, Pensacola, USA). Participants wore the device continuously for three consecutive 24-h periods, except during water-based activities. Data were collected at 30 Hz and harmonized using R (v4.1.2) following the SADEY data harmonization protocol for preschoolers [13]. Prior to sleep processing, data were processed to identify nonwear during waking hours, sedentary behavior, physical activity, using the "PhysicalActivity" package [13]. The data were then aggregated into 60-s epochs for sleep analysis using the same package. Sleep periods were identified using the decision-tree algorithm in the PhyActBedRest package [13, 14]. Nonwear during sleep was defined as at least 90 min of consecutive zero counts with up to 2 min of nonzero interruption [13, 14]. Nighttime sleep duration was defined as the time between sleep onset and offset, occurring between 06:00 pm and 12:00 pm (noon) the next day, and nap duration as sleep between 12:00 pm (noon) and 6 pm. Total sleep duration was the sum of nighttime sleep duration and nap duration. Nighttime sleep efficiency was derived using the Sadeh algorithm [15]. For sleep timing, nighttime sleep midpoint, the point in time halfway between nighttime sleep onset and offset, was selected to indicate the lateness of child sleep schedule. Consistent with previous studies with young children, a minimum of three 24-h periods of accelerometer data was considered valid for the present analysis [16, 17]. Average sleep duration variables, sleep midpoint, and sleep efficiency across days with usable data were calculated. Regarding nighttime sleep variability, the intraindividual standard deviation of nighttime sleep duration, midpoint, and efficiency was calculated, respectively, representing the amount of variation from the individual mean across the days with usable data.

Family practices.

Parents/guardians (parents thereafter) reported family practices using a questionnaire. The questions, response options, and coding system are detailed in Supplementary Table S2. In all phases, parents answered questions about bedtime routine frequency, the frequency of parental smartphone use during bedtime routines,

[1] In the cited study (reference [8]), the terms "predominantly-Asian countries" and "predominantly-Caucasian countries" were used. To maintain consistency with the terminology in our manuscript, we have replaced these with "Asian countries" and "Minority World countries," respectively.

[2] The same approach was applied to reference [9].

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the presence of electronic devices in the child's bedroom, and child electronic device use within 2 h before bedtime. In Phase III, the questionnaire was expanded to include questions about sleep arrangement, and the number of co-sleeping children and adults. Parents also reported other family practices including child screen time (Phases I–III), outdoor time, and unhealthy diet frequency (Phases II and III).

Geocultural region.

Countries were classified into nine geocultural regions: the Minority World, the Pacific Islands, Sub-Saharan Africa, Eastern Europe, Northeast Asia, Southeast Asia, South Asia, the Middle East and North Africa, and Latin America (Supplementary File: Table S1).

Demographic variables.

Country income was classified by the World Bank into low, lower-middle, upper-middle, and high-income categories [18]. The urbanicity of the study sites was dichotomized as either urban or rural based on local criteria. Parents reported their education, which was further categorized into "vocational or tertiary education" and "high school or below," as well as their sex and child sex. Child age in months and parental age were calculated based on the reported dates of birth and the questionnaire data collection date.

Statistical analysis

Statistical analyses were performed using R (v4.1.2). Participants with data on at least one outcome measure and all covariates were included in the analysis to maximize diversity. Nighttime sleep characteristics and nap duration ($n = 1$) were examined for outliers and truncated per prespecified criteria [19]. Descriptive statistics were calculated. To address the primary study objectives, linear mixed models were used to estimate marginal means of nighttime sleep characteristics and nap duration by geocultural region using R packages "lme4" and "lmerTest." Overall mean values and standard deviations for each sleep variable across geocultural regions were calculated. Additionally, z-scores of the estimated marginal means were computed for each sleep variable specific to a geocultural region. A z-score close to zero indicated a value near the average across all regions. Positive z-scores indicated above-average values whereas negative z-scores indicated below-average values. In this context, higher z-scores were more favorable for nighttime sleep duration and efficiency but less favorable for nighttime sleep timing and variability. Radar charts were created using the z-scores to visualize each region's sleep profile. Differences in nighttime sleep characteristics, nap duration, and total sleep duration between Majority World regions and the Minority World were examined using the same mixed models. Cohen'*d* was calculated as the unstandardized beta divided by the residual standard deviation and interpreted as small ($d = 0.2$), medium ($d = 0.5$), and large ($d = 0.8$) [20]. The proportion of variation in each sleep variable explained by geocultural region was calculated by comparing the *R*-squared values from the full model with those from a model excluding geocultural region. The effect sizes for variance explained were defined as small ($\Delta R^2 = 0.01$), medium ($\Delta R^2 = 0.09$), and large ($\Delta R^2 = 0.25$) [20]. To address the secondary objective, linear (continuous outcomes) and generalized (categorical outcomes) mixed models were employed to examine the differences in family practices across geocultural regions, using the Minority World as the reference group. Marginal means for continuous outcomes and frequencies for categorical outcomes were calculated by geocultural region. All models were adjusted for covariates, including country income, urbanicity, parental education, and child age, and the clustering effect of country. Preliminary analysis showed that child sex, parental age, and parental sex were not significantly associated with the outcome variables and therefore were not considered as model covariates. A significance level of p-value < .05 was used.

Results

Of the 3698 eligible participants, 3507 had data on child age, parental education, urbanicity, country income, and at least one outcome and were included in the analyses. The sample had a diverse demographic background, with an average age of 4.4 ± 0.6 years (Table 1). For primary outcomes, 1950 children had at least three days of accelerometer sleep data. There were no significant differences in child age ($p = .166$) or sex ($p = .289$), nor in parental age ($p = .747$) or sex ($p = .321$), between those with three or more days of accelerometer data and those without. Significant differences were observed in the distribution of parental education, urbanicity, country income, and geocultural regions. A higher proportion of participants with three or more days of accelerometry data had less educated parents, lived in rural areas, came from low-income countries, and were from Middle East and North Africa, or sub-Saharan Africa, compared to those with no or less than three days of accelerometry data. Conversely, a lower proportion of participants with three or more days of accelerometry data were from high-income countries or the Southeast Asia region, compared to those with no or less than three days of accelerometry data.

Different sleep profiles were observed across geocultural regions, accounting for child age, parental education, urbanicity, and country income (Figure 1; Supplementary Table S3). Despite distinct profiles, the Minority World (Figure 1A) and the Pacific Islands (Figure 1B) generally exhibited more favorable nighttime sleep characteristics (positive z-scores for duration and efficiency; negative z-scores for timing and variability) and shorter nap duration (z-scores: −0.53 and −0.88, respectively). The Minority World had the smallest night-to-night variability in sleep duration (40 min; $z = -1.82$) and sleep midpoint (25 min; $z = -1.27$). The Pacific Islands showed the longest nighttime sleep duration (11.0 h; $z = 0.86$), highest sleep efficiency (89%; $z = 1.14$), earliest sleep midpoint (01:36; $z = -1.52$), and smallest night-to-night variability in efficiency (6%; $z = -1.79$). Sub-Saharan Africa (Figure 1C) had sleep characteristics near the overall mean (z-scores: −0.44 to 0.37), with an earlier sleep midpoint ($z = -0.77$) and shorter nap duration ($z = -0.90$).

Two patterns emerged in the remaining Majority World regions. One pattern, characterized by shorter nighttime sleep duration (z-scores: −1.10 to −1.36), lower nighttime sleep efficiency (z-scores: −1.07 to −1.72), and longer nap duration (z-scores: 0.82 to 1.76), was observed in Eastern Europe (Figure 1D), Northeast Asia (Figure 1E), and Southeast Asia (Figure 1F). Eastern Europe had the largest night-to-night variability in sleep efficiency (11%; $z = 1.64$) and the longest nap duration (1.5 h; $z = 1.76$); Northeast Asia had the lowest sleep efficiency (80%; $z = -1.72$), while Southeast Asia had the lowest shorter sleep duration (9.3 h; $z = -1.36$). The other sleep pattern, characterized by later nighttime sleep midpoints (z-scores: 0.69 to 1.57) and greater night-to-night variability in sleep duration (z-scores: 0.58 to 1.56) and in sleep midpoint (z-scores: 0.63 to 2.00), was seen in South Asia

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Table 1. Descriptive statistics

Variables		Whole sample (*n* = 3507)	Subsample with three or more days of accelerometry data (*n* = 1950)
Child age (months)		52.52 ± 7.12	52.37 ± 7.22
Child sex (%)	Female	49.8	50.6
	Male	50.2	49.4
Parent age (years)		34.47 ± 7.43	34.37 ± 7.53
Parent sex (%)	Female	82.8	83.3
	Male	17.2	16.7
Parental education (%)	Vocational or tertiary	51.2	44.7
	High school or below	48.8	55.3
Urbanicity (%)	Urban	51.8	50.3
	Rural	48.2	49.7
Country income (%)	Low	13.8	22.0
	Low-middle	39.6	37.4
	Upper-middle	23.3	21.6
	High	23.4	19.0
Geocultural region (%)	The Minority World	14.5	12.7
	Eastern Europe	6.1	7.1
	Latin America	5.2	5.0
	Northeast Asia	14.8	14.7
	Southeast Asia	12.7	4.0
	South Asia	9.7	8.9
	Pacific Islands	2.3	2.5
	The Middle East & North Africa	8.4	10.1
	Africa	26.3	35.0

Data are presented in mean and standard deviations for continuous variables (child age, parental age) and percentage for categorical variables (child sex, parental sex, parental education, urbanicity, country income, and geocultural region).

(Figure 1H), the Middle East and North Africa (Figure 1I), and Latin America (Figure 1J). South Asia showed the largest variability in sleep duration (83 min; z = 1.56), the Middle East and North Africa had the latest sleep midpoint (03:29; z = 1.57), and Latin America had the largest variability in sleep midpoint (47 min; z = 2.00).

As shown in Table 2, geocultural region explained up to 30.1% of the variation in sleep characteristics, with large effect sizes for nighttime sleep midpoint (30.1%) and nap duration (28.4%), medium-to-large effect sizes for nighttime sleep duration (12.4%) and sleep efficiency (9.4%), and small-to-medium effect sizes for sleep variability characteristics (2.8% to 4.1%) [20]. In comparison to the Minority World, Eastern Europe, Northeast Asia, and Southeast Asia had approximately 1 h less nighttime sleep duration (*d*: −1.03 to −1.26), 3.4%–5.9% lower sleep efficiency (*d*: −0.48 to −0.83) and 0.6–1.1 h longer nap duration (*d*: 1.14 to 1.93). Northeast Asia, the Middle East and North Africa, and Latin America had over 1 h later sleep midpoints (*d*: 1.81 to 2.35). Variability in sleep duration was 21–43 min higher in Sub-Saharan Africa Northeast Asia, South Asia, the Middle East and North Africa, and Latin America (*d*: 0.52 to 1.07). Latin America had 24 min more variability in sleep midpoint (*d* = 0.95), while Eastern Europe (*d* = 0.55) and Northeast Asia (*d* = 0.57) had 3% higher variability in sleep efficiency. There were no significant differences in any sleep characteristics between the Pacific Islands and the Minority World, nor in total sleep duration between any Majority World region and the Minority World.

Figure 2 and Supplementary Table S3 present descriptive data on family practices by geocultural regions. Table 3 shows differences in family practices between each Majority World region and the Minority World, adjusted for child age, parental education, urbanicity, and country income. No significant differences were observed in the scores for bedtime routine frequency (on a scale of 1 to 5; Table 3). However, over 70% of families in the Minority World and Eastern Europe reported daily bedtime routines, compared to only about 25% of families in Sub-Saharan Africa, Middle East and North Africa, and the Pacific Islands (Figure 2; Supplementary Table S3). Parents in Northeast Asia and Southeast Asia had significantly higher frequency of smartphone use during bedtime routines (0.77 unit and 0.99 unit, respectively, on a scale of 1–5; Table 3), compared to the Minority World. As shown in Figure 2 and Supplementary Table S3, the proportion of parental using smartphones during bedtime routines (sometimes or every day) was highest (over 40%) in Northeast and Southeast Asia but relatively low in the Minority World (20%) and Eastern Europe (4%).

In terms of the presence of electronic devices in the child's bedroom, the highest proportions were observed in Eastern Europe, Latin America, and South Asia (52%–71% Figure 2; Supplementary Table S3). Families in these regions were 6 to 17 times more likely to have electronic device in the child's bedroom, compared to those from the Minority World (Table 3). Nearly 60% children used an electronic device within 2 hours before bedtime,

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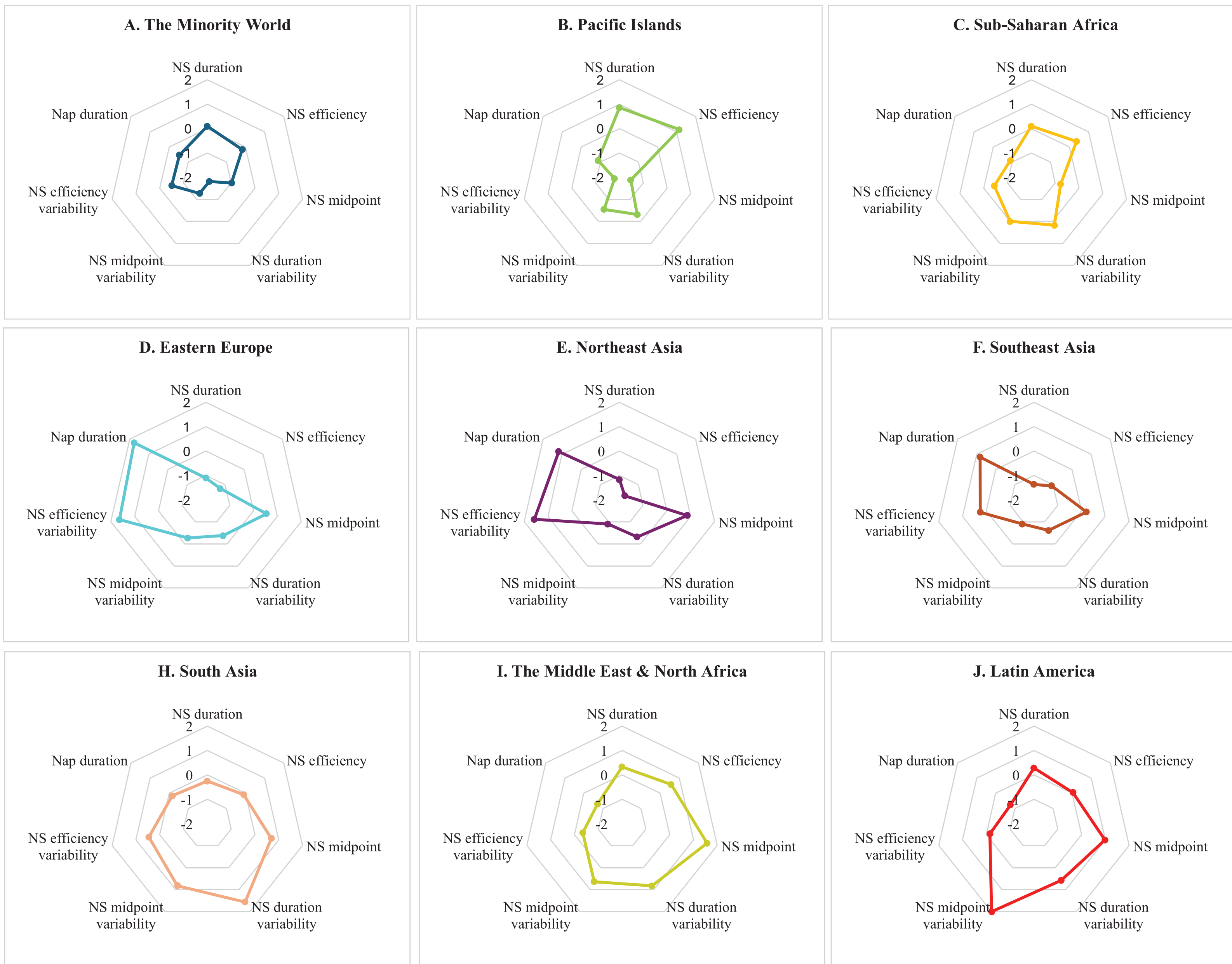

Figure 1. Preschooler sleep profiles across geocultural regions. The radar charts depict sleep profiles in preschoolers from the Minority World (A), the Pacific Islands (B), Sub-Saharan Africa (C), Eastern Europe (D), Northeast Asia (E), Southeast Asia (F), South Asia (H), the Middle East and North Africa (I), and Latin America (J). Numbers in the radar charts represent z-scores. The estimated marginal means and z-scores of each sleep characteristic by region are presented in Supplementary Table S3. A z-score close to zero indicates a value near the average across all regions, with positive values indicating above-average and negative values indicating below-average characteristics. Abbreviation: NS, nighttime sleep.

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Table 2. Differences in nighttime sleep characteristics between the Majority World regions and the Minority World

Geocultural region	Nighttime sleep duration (min/d)		Nighttime sleep midpoint (h)		Nighttime sleep efficiency (%/d)		Nighttime sleep duration variability (min)		Nighttime sleep midpoint variability (h)		Nighttime sleep efficiency variability (%)		Nap duration (min/d)		Total sleep duration (min/d)	
	B (95%CI)	P-value	B (95%CI)	P-value	B (95%CI)	P-value	B (95%CI)	P-value	B (95%CI)	P-value	B (95%CI)	P-value	B (95%CI)	P-value	B (95%CI)	P-value
Reference group: the Minority World																
Pacific Islands	34.86 (−38.01, 107.72)	.332	−0.32 (−1.73, 1.08)	.638	4.97 (−0.11, 10.05)	.055	21.09 (−10.27, 52.45)	.176	0.09 (−0.24, 0.41)	.591	−1.81 (−4.34, 0.72)	.152	−9.79 (−54.09, 34.52)	.651	24.98 (−47.36, 97.33)	.482
Sub-Saharan Africa	0.26 (−61.79, 54.54)	.992	0.13 (−0.91, 1.17)	.797	2.04 (−1.80, 5.87)	.284	**26.85 (3.21, 50.49)**	**.028**	0.14 (−0.11, 0.38)	.252	0.08 (−1.83, 2.00)	.928	−10.26 (−43.31, 22.79)	.527	−10.10 (−63.99, 43.85)	.703
East Europe	**−54.46 (−103.99, −4.92)**	**.033**	0.93 (−0.03, 1.89)	.056	**−4.10 (−7.50, −0.70)**	**.020**	20.34 (−0.74, 41.41)	.058	0.12 (−0.10, 0.33)	.287	**2.99 (1.33, 4.66)**	**.001**	**64.61 (34.48, 94.71)**	**<.001**	10.10 (−39.01, 59.26)	.674
Northeast Asia	**−57.27 (−95.92, −18.63)**	**.006**	**1.12 (0.38, 1.87)**	**.005**	**−5.87 (−8.56, −3.19)**	**<.001**	**21.01 (4.43, 37.60)**	**.016**	0.05 (−0.12, 0.22)	.568	**2.90 (1.57, 4.24)**	**<.001**	**48.22 (24.73, 71.72)**	**<.001**	−9.12 (−47.49, 29.25)	.627
Southeast Asia	**−66.35 (−110.40, −22.29)**	**.005**	0.73 (−0.09, 1.55)	.078	**−3.41 (−6.78, −0.04)**	**.047**	17.49 (−3.00, 37.98)	.091	0.04 (−0.17, 0.25)	.710	1.05 (−0.75, 2.84)	.244	**38.06 (11.16, 64.96)**	**.007**	−28.79 (−72.65, 15.08)	.190
South Asia	−15.73 (−69.89, 38.44)	.554	1.02 (−0.01, 2.06)	.053	0.29 (−3.54, 4.11)	.878	**43.27 (19.69, 66.85)**	**.001**	0.23 (−0.01, 0.47)	.064	1.34 (−0.56, 3.25)	.157	10.37 (−22.58, 43.32)	.521	−5.40 (−59.20, 48.40)	.838
The Middle East & North Africa	10.57 (−45.82, 66.97)	.701	**1.57 (0.48, 2.65)**	**.007**	2.83 (−1.11, 6.78)	.151	**34.53 (10.17, 58.89)**	**.008**	0.22 (−0.04, 0.47)	.090	0.21 (−1.74, 2.15)	.824	−5.03 (−39.33, 29.27)	.763	5.50 (−50.50, 61.51)	.841
Latin America	8.69 (−41.38, 58.75)	.723	**1.21 (0.25, 2.17)**	**.016**	0.84 (−2.69, 4.36)	.629	**31.58 (9.86, 53.31)**	**.006**	**0.37 (0.14, 0.59)**	**.002**	0.49 (−1.28, 2.27)	.569	−6.61 (−37.05, 23.84)	.657	−1.97 (−47.75, 51.69)	.935
Residual SD	52.63		0.67		7.09		40.54		0.39		5.26		33.35		53.52	
ΔR^2	0.124		0.301		0.094		0.041		0.039		0.028		0.284		0.039	

Abbreviations: B, unstandardized beta coefficient; CI, confidence interval; SD, standard deviation; ΔR^2, the change in *R*-squared values from the full model with those from the model excluding geocultural region, representing the proportion of variance in the sleep variable explained by geocultural region.
Bold fonts indicate p-value < .05.
Subsample with three or more days of accelerometry data ($n = 1950$) was included in the analysis. All models included the fixed slopes of country income level, urbanicity, parental education, and child age, as well as a random intercept of country.

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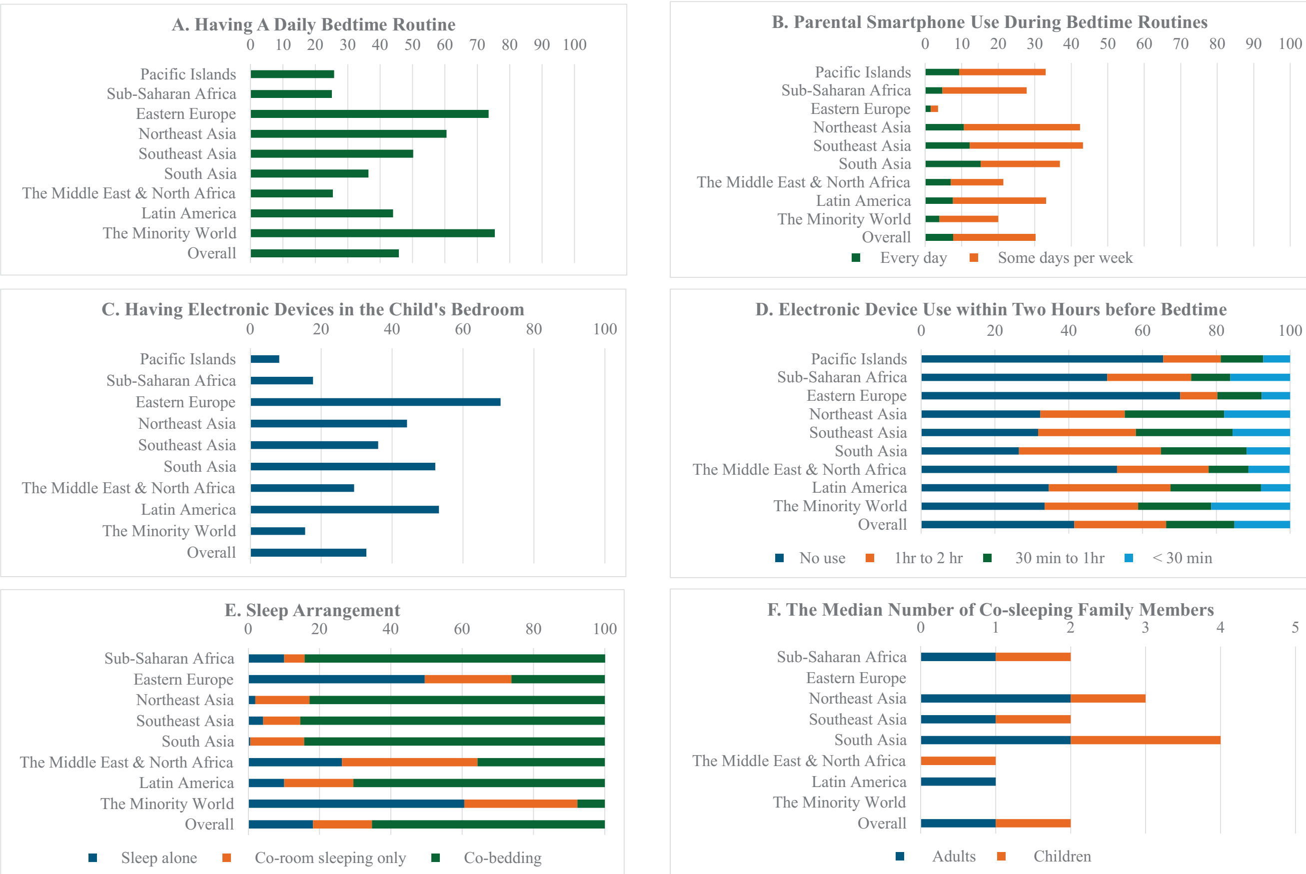

Figure 2. Family practices across geocultural regions. The bar charts present frequencies for having daily bedtime routines (A), parental smartphone use (B), having electronic device in the child's bedroom (C), child electronic device use within two hours before bedtime (D), and sleep arrangements (E), along with the median number of co-sleeping family members (F), by geocultural region. The corresponding data is provided in Supplementary Table S4.

with even higher proportions observed in Latin America, the Minority World, and the three Asia subregions (65%–73%; Figure 2; Supplementary Table S3). There were no significant differences in the odds of child electronic device use within two hours before bedtime across most regions in comparison to the Minority World, with the exception of Eastern Europe where lower odds were observed.

Sleep arrangement, measured only in Phase III, demonstrated significant geocultural differences. As shown in Table 3, Asia was 50 times more likely and Latin America was 7 times more likely to have co-sleeping arrangements, compared to the Minority World. South Asia and Northeast Asia had the highest proportions of co-sleeping arrangements (>97%) and the highest median numbers of family members ($n \geq 3$) co-sleeping with the child, compared to other regions (Figure 2; Supplementary Table S3). Outdoor play time, screen time, and the frequency of unhealthy snack intake did not significantly differ between the Majority World regions and the Minority World.

Discussion

This study is, to the best of our knowledge, the first to examine geocultural differences in preschooler sleep characteristics and relevant family practices in a global sample. Diverse sleep profiles were observed across geocultural regions, independent of country income levels, urbanicity, parental education, and child age. Children from the Majority World regions, except the Pacific Islands, had less optimal sleep characteristics compared to those from the Minority World. Variations in sleep-related family practices were also observed, reflecting the geocultural variability in approaches to child sleep.

The fact that geocultural region explained up to 30% of variance in the sleep characteristics highlights its potential role in shaping preschoolers' sleep and the importance of considering geocultural contexts in sleep research. The two sleep patterns observed in the Majority World are concerning due to potential links with suboptimal health outcomes in this age group. Children from Eastern Europe, Northeast Asia, and Southeast Asia tend to sleep less and have more difficulty staying asleep at night and take longer nap, compared to other regions. Although total sleep duration did not differ significantly from Minority World, research has linked less consolidated nighttime sleep and prolonged naps with higher risks of obesity and poor cognitive and motor skills in young children [16, 17, 21]. Lower nighttime sleep efficiency has also been associated with poor behavioral regulation in this age group [22]. The second sleep pattern, seen in South Asia, the Middle East and North Africa, and Latin America, indicates delayed and more irregular nighttime sleep schedules in children from these regions compared to other regions. Though research on these sleep characteristics is limited in this age group, emerging evidence suggests that this sleep pattern is unfavorably associated with motor skills in young children [16]. It should be noted that most evidence linking sleep and health outcomes came from the Minority World. As these two sleep patterns were observed

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Table 3. Differences in family practices between the Majority World regions and the Minority World

Geocultural region	Bedtime routine frequency (scores: 1–5; *n* = 3423)		The frequency of parental smartphone use during bedtime routine (scores:1–5; *n* = 3396)		Electronic device in the bedroom (yes vs. no; *n* = 3464)		Child electronic device use within two hours before bedtime (yes vs. no; *n* = 3466)		Sleep arrangement[*,†] (co-sleeping vs. solo-sleeping; *n* = 1822)		Outdoor time[‡] (h/d; *n* = 2741)		Child screen time (h/d; *n* = 3466)		Unhealthy snack frequency[†] (scores: 1–10; *n* = 1802)	
	B (95%CI)	P-value	B (95%CI)	P-value	OR (95%CI)	P-value	OR (95%CI)	P-value	OR (95%CI)	P-value	B(95%CI)	P-value	B (95%CI)	P-value	B (95%CI)	P-value
Reference group: the Minority World																
Pacific Islands	−0.13 (−1.63, 1.38)	.871	0.57 (−0.80, 1.93)	.423	0.44 (0.04, 5.18)	.510	0.35 (0.03, 4.88)	.438	–	–	–	–	−0.69 (−2.46, 1.09)	.456	–	–
Sub-Saharan Africa	−0.39 (−1.43, 0.66)	.476	0.58 (−0.37, 1.54)	.243	0.80 (0.15, 4.34)	.797	0.86 (0.15, 5.81)	.932	0.92 (0.48, 1.78)	.814	1.78 (−1.22, 4.79)	.256	−0.43 (−1.66, 0.79)	.492	1.95 (−1.97, 5.87)	.346
East Europe	0.10 (−9.11, 1.12)	.841	−0.51 (−1.43, 0.42)	.292	**16.57 (3.20, 85.85)**	**.001**	**0.10 (0.01, 0.56)**	**.010**	2.85 (0.90, 8.97)	.074	−0.32 (−2.88, 2.23)	.806	−0.93 (−2.12, 0.26)	.135	−0.39 (−3.13, 2.35)	.787
Northeast Asia	−0.12 (−0.09, 0.62)	.753	**0.77 (0.09, 1.44)**	**.035**	3.22 (0.98, 10.55)	.053	0.87 (0.24, 3.11)	.833	**49.86 (18.71, 132.86)**	**<.001**	−0.83 (−3.40, 1.74)	.540	−0.54 (−1.40, 0.32)	.229	1.06 (−2.94, 5.06)	.614
Southeast Asia	0.10 (−0.75, 0.95)	.820	**0.99 (0.22, 1.77)**	**.019**	2.78 (0.71, 10.92)	.143	1.25 (0.29, 5.47)	.763			0.02 (−2.14, 2.18)	.986	−0.29 (−1.28, 0.71)	.578	0.90 (−1.44, 3.24)	.467
South Asia	−0.59 (−1.68, 0.50)	.295	0.90 (−0.09, 1.89)	.085	**7.90 (1.36, 45.97)**	**.021**	2.65 (0.39, 17.93)	.318			0.56 (−2.00, 3.71)	.563	−0.38 (−1.66, 0.90)	.566	0.66 (−3.03, 4.36)	.731
The Middle East/ North Africa	−0.20 (−1.34, 0.94)	.733	0.37 (−0.66, 1.41)	.489	1.14 (0.18, 7.22)	.892	0.40 (0.05, 3.03)	.379	1.55 (0.58, 4.12)	.380	0.80 (−2.18, 3.77)	.605	−0.28 (−1.62, 1.06)	.682	1.51 (−2.07, 5.10)	.423
Latin America	−0.42 (−1.46, 0.62)	.437	0.43 (−0.51, 1.38)	.377	**5.97 (1.14, 31.34)**	**.034**	1.83 (0.30, 11.24)	.513	**7.05 (3.05, 16.29)**	**<.001**	1.27 (−2.01, 4.55)	.456	0.02 (−1.20, 1.24)	.972	0.85 (−2.20, 3.91)	.596

Abbreviations: B, unstandardized beta coefficient; OR, odds ratio.
Bold font indicates p-value < .05.
Models included the fixed slopes of country income level, urbanicity, parental education, and child age, as well as the random intercept of country.
[*]Data were only available for countries in study phase III.
[†]Due to the low frequency of children in the "sleep alone" category—Northeast Asia (*n* = 2), Southeast Asia (*n* = 4), and South Asia (*n* = 1)—these regions were combined into a single geocultural category for the analysis. This new category includes a total of 7 children who slept alone. Given this low frequency, a logistic regression model was employed instead of a general linear model to reduce complexity and improve estimate reliability.
[‡]Data were only available for countries in study phases II and III.

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in the Majority World, it is important to determine whether the health relationships differ in magnitude.

The large effect size differences in sleep characteristics observed between the Majority and Minority World may contribute to health disparities and hinder progress toward the United Nations Sustainable Development Goals. Our findings for Northeast, Southeast, and South Asia align with an earlier questionnaire-based study showing later bedtimes and shorter nighttime sleep in preschoolers from Asian countries compared to the Minority World countries[3] [9]. However, our study did not consistently find significant differences in nighttime sleep duration and timing across all three Asia subregions compared to the Minority World, with varying nighttime sleep efficiency and variability across the three regions. These discrepancies reinforce not treating Asian subregions as a homogeneous group. Our study provided initial evidence that children from several Majority World regions beyond Asia had less favorable sleep characteristics compared to the Minority World. Future efforts are needed to understand and mitigate the potential impact of these sleep disparities to support healthy child development and enhance equity.

Our findings have important implications for the applicability of current sleep recommendations for early childhood, such as those in the WHO guidelines [23] and the Asia-Pacific consensus statement [24]. The best available global evidence supporting these recommendations came predominantly from the Minority World [25, 26], which limits their applicability to children from the Majority World. Moreover, current sleep recommendations focus mainly on sleep quantity, whereas other dimensions, such as sleep efficiency, sleep timing, and sleep variability, are not included due to insufficient evidence. Even with sleep quantity, guidance is centered on total sleep duration, given limited understanding of optimal balance between daytime and nighttime sleep for this age group. More comprehensive, global representative evidence is needed to update sleep recommendations at international and regional levels, making them more inclusive for all children.

The less optimal sleep characteristics observed in children from the Majority regions, compared to the Minority World may be due to differences in sleep-related family practices. For example, high-quality bedtime routines support healthy sleep habits [27]. While our study did not find significant differences in bedtime routine frequency, parents in Northeast and Southeast Asia regions were more likely to used smartphones during these routines than those in the Minority World. Such a behavior may cause distractions and reduce parental responsiveness, making it harder for the child to settle down and feel ready to sleep [28]. The observed higher likelihood of electronic devices in children's bedrooms in Eastern Europe, Latin America, and South Asia may also contribute to less favorable sleep characteristics in these regions. Although parental perceptions of their child's prebedtime electronic device use did not differ, having devices in the bedroom may lead to increased sneaky screen use when the child was supposed to be sleeping [29]. Such use often occurs without parental awareness and could affect the child's sleep [29]. Building on previous research that compared individual studies on sleep arrangement [30, 31], our findings provide initial global evidence on geocultural differences, in particular a higher likelihood of co-sleeping in Asia and Latin America compared to the Minority World. Despite mixed findings for the influence of co-sleeping on child sleep [32], parental prebedtime behaviors, such as electronic device use, may have a more unfavorable impact on co-sleeping children compared to solo-sleepers. Additionally, the relatively high number of family members sharing a room or bed in Asia may cause overcrowding, potentially disrupting child sleep. Given these observed geocultural differences in sleep-related family practices, tailored strategies are needed to support parents, particularly in the Majority World, in helping their children establish healthy sleep habits.

Although daily screen time, outdoor time, and unhealthy snack consumption may influence individual sleep [4, 33], no differences were observed in these practices across geocultural regions. Beyond the factors examined, other family factors (e.g. parental attitudes towards sleep [34], parenting style [35], family structure [36]), societal factors (e.g. workplace and preschool schedules [37], public health policies, supporting systems), and physical environmental factors (noise, light, temperature, humidity, neighborhood safety) may also vary geoculturally and contribute to differences in child sleep profiles. Future research should explore these factors to inform culturally sensitive practice and policies that promote healthy sleep in diverse geocultural contexts.

Strengths of this study include a large, diverse sample, device-based sleep measurement, examination of multidimensional sleep profiles, and consideration of various confounding factors. A limitation is the use of convenience sampling at both the country and within country level. In certain regions, such as the Pacific Islands, the limited number of participating countries may affect representativeness. The primary outcome was limited to children with at least three days of accelerometry data, potentially biasing the sample by excluding noncompliant participants or those with technical issues. For logistical reasons, the study did not differentiate weekday and weekend sleep, which may introduce measurement error if a participant's sleep duration or timing varied significantly between these periods. However, variability in these sleep characteristics was considered in sleep profiles. Additionally, sleep was measured across different seasons and shortly after COVID-19 restrictions in some countries, which could have influenced the results. Finally, the questionnaire measures of family practices may be prone to social desirability bias or recall limitations, although they demonstrated good reliability in our sample.

Conclusion

This study provides insights into multidimensional sleep profiles in preschoolers and related family practices across the globe. Geocultural differences explained up to a third of the variance in sleep profiles, with several Majority World regions demonstrating less optimal sleep characteristics compared with the Minority World. These disparities underscore the need to examine health impacts, identify healthy sleep profiles for child development by region, and develop more inclusive sleep recommendations at both global and regional levels. The notable geocultural differences in sleep-related family practices also emphasize the need to support parents, particularly in the Majority World. Future research should explore additional factors to understand the mechanism underlying these differences in preschoolers' sleep and inform tailored sleep promotion strategies.

Supplementary material

Supplementary material is available at *SLEEP* online.

[3] See footnotes 1 and 2 in the Introduction.

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Data availability

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request

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