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Effects of the COVID-19 lockdown on sleep duration in children and adolescents: A survey across different continents

Athanasios G. Kaditis MD[1] | Adrienne Ohler PhD[1] | Alex Gileles-Hillel MD[2,3,4] | Shoham Choshen-Hillel PhD[5] | David Gozal MD, MBA[1] | Oliviero Bruni MD[6] | Secil Aydinoz MD[1] | Rene Cortese PhD[1] | Leila Kheirandish-Gozal MD, MSc[1]

[1]Department of Child Health and Child Health Research Institute, Women's and Children's Hospital, University of Missouri School of Medicine, Columbia, Missouri, USA

[2]Faculty of Medicine, Hebrew University of Jerusalem, Jerusalem, Israel

[3]The Wohl Center for Translational Medicine, Hadassah University Medical Center, Kiryat Hadassah, Jerusalem, Israel

[4]Pediatric Pulmonology and Sleep Unit, Department of Pediatrics, Hadassah Medical Center, Jerusalem, Israel

[5]School of Business Administration and the Federmann Center for the Study of Rationality, Hebrew University of Jerusalem, Jerusalem, Israel

[6]Department of Developmental and Social Psychology, Sapienza University, Rome, Italy

Correspondence

Leila Kheirandish-Gozal, MD, MSc, Department of Child Health and Child Health Research Institute, Women's and Children's Hospital, University of Missouri School of Medicine, Columbia, MO 65201, USA.
Email: gozall@missouri.edu

Abstract

Background: A parent survey was conducted to assess the sleep habits of children residing in various countries before and during the SARS-CoV-2 pandemic. It was hypothesized that lockdown would be associated with increased sleep duration.

Methods: Outcomes were changes in bedtime, wake time, and sleep duration in the pandemic compared to before. Logistic regression was applied to evaluate the effects of age and covariates on outcomes.

Results: A total of 845 questionnaires completed from May 1 to June 10, 2020 were analyzed (45.8% female; age 3–17 years). During the pandemic, 23.1% of preschoolers, 46.2% of school-age children, and 89.8% of adolescents were going to bed after 10 p.m. on weekdays compared to 7.1%, 9.4%, and 57.1% respectively before the pandemic, with these proportions being higher on weekends. Likewise, 42.5% of preschoolers, 61.3% of school-age children, and 81.2% of adolescents were waking after 8 a.m. on weekdays (11.6%, 4.9%, and 10.3%, before) with these proportions being greater on weekends. Sleep duration did not change in 43% of participants on weekdays and in 46.2% on weekends. The 14–17 years group had fourfold increased odds for longer sleep duration on weekdays ($p < .01$), and children aged 6–13 years had twofold increased odds for longer sleep duration on weekends relative to the 3–5 years age group ($p = .01$).

Conclusions: Although lockdown was associated with later bedtime and wake time, this shift did not alter sleep duration in more than 40% of children. Yet, compared to preschoolers, high school-aged children were more likely to sleep more on weekdays and primary school children on weekends.

KEYWORDS

disturbed sleep quality, insomnia, pandemic, sleep deficit

1 | INTRODUCTION

The emergence of a novel coronavirus, SARS-CoV-2, in December 2019 has rapidly evolved into one of the major pandemics in mankind's history. To contain the spread of the virus, many governments as well as local authorities across the globe have urged their citizens to remain at home and have implemented strict social distancing, while enterprises and schools have remained closed. As a result, the SARS-CoV-2 pandemic has produced major adverse health, social and financial consequences. In a recently published survey of more than 2500 adults from 49 countries, it was shown that the pandemic adversely affected sleep quality across the world.[1] Indeed, although overall sleep duration increased, 40% of the respondents reported decreased sleep quality. Consumption of sleeping pills increased by 20% compared to pre-pandemic levels.[1] Several reports from single countries involving adult participants demonstrated delayed bedtime and wake time during the lockdown period compared to before the pandemic, as well as increased sleep duration among young adults, while other studies showed unchanged or even decreased sleep duration.[2–4] Disturbed sleep quality, insomnia, and frequent awakenings were commonly reported problems in adults.[5,6]

Children represent a particularly active population group.[7] Confinement at home during the lockdown period has led to disruption of their daily lifestyle, principally as cessation of in-person school attendance, transition to online learning, discontinuation of interactions with peers, and limited outdoor activities.[8,9] Social isolation, unconstrained sleep schedules, prolonged screen exposure, along with the inherent uncertainties and fear related to the pandemic likely affected their sleep patterns. Indeed, a few descriptive studies of children from countries with high incidence rates of SARS-CoV-2 infection revealed changes in sleep-wake routines.[10,11] In a small cohort of overweight children and adolescents from Verona, Italy, mean sleep time increased during the lockdown period.[11] Additionally, in a study of 1619 preschoolers from Zunyi, China, both bedtime and wake time were delayed in comparison with the respective patterns in a 2018 control population sample.[10] Because wake time was more delayed than bedtime, the mean sleep duration increased.[10] However, in both studies, changes in sleep duration were summarized as population means without mentioning any subgroups of children whose sleep duration might have diverged in opposite directions.

In contrast to previous pediatric reports that were focused on specific country regions, we have collected data on children's sleep habits across the globe via an international online survey of parents. This survey was initiated after 2 months of ongoing lockdown measures and spanned a period of 41 days to account for geographical differences in the timing of the imposition of SARS-CoV-2 containing policies in various countries. We hypothesized that sleep duration increased during the lockdown period and explored the potential associations of this change with alterations in daytime routines, for example not attending school, not participating in physical activity, and spending more time on electronic devices.

2 | Patients and methods

2.1 | Procedure and participants

A cross-sectional online survey of adult responders (≥18 years of age) who identified themselves as parents of children (<18 years of age) was conducted. Informed consent was obtained before participation in the study, which was approved by the University of Missouri Institutional Review Board (2022363/05-01-2020). Study participants were invited to participate in a survey on the sleep patterns of their children during the COVID-19 pandemic. They were informed that the data collected would be kept anonymous and deidentified, and that their contribution to the study would be completely voluntary.

The survey was distributed online worldwide using Qualtrics software (Qualtrics LLC) from May 1 to June 10, 2020 via a range of methods: invitation via e-mail, University of Missouri website, and social media platforms, such as Facebook®, WhatsApp®, Twitter®, and LinkedIn®. Responses to all questions were not required to submit the survey.

2.2 | Survey instrument

Responders were asked to answer 17 multiple-choice items and one open-ended item all translated into the local language (Supporting Information Online Supplement-Questionnaire). The average time for completion of the survey was 5–7 min. Parents were instructed to answer all or some of the questions and fill in one survey for each of their children. Excluded from the analysis were respondents indicating that the child did not sleep in the same house or did so only sometimes.

Questions were grouped in 3 blocks. *Block 1* comprised questions on child's demographics, frequency of sleeping at home with the parent, chronic medical conditions, and parental socioeconomic status. Information was also collected about the presence of other household members who had been infected by SARS-CoV-2. *Block 2* contained questions on screen time spent by the child on computer, cell phone, television, and video games as well as bedtime and wake time before and after the pandemic separately for weekdays and weekends. *Block 3* questions were focused on sleep patterns and characteristics like time to falling asleep, need for a special object like doll or stuffed animal, nightmares, snoring, daytime sleepiness, and so on, before and after the SARS-CoV-2 crisis (results not presented in this manuscript). The opinion of the parent for the cause of the child's sleep schedule changes were also recorded ("more time at home" (yes/no); "doesn't have to wake up too early in the morning" (yes/no); "more time on social media" (yes/no); "less physical activity" (yes/no)".

2.3 | Outcomes and data analysis

Three main outcome measures were used: change in bedtime, change in wake time, and change in sleep duration. First, bedtime and wake

times were recorded as ordinal variables with codings 1–4 (Table S1; Online Supplement-Tables). Four distinct options for bedtime were offered in the survey: (a) 6–8 p.m. (=1); (b) 8–10 p.m. (=2); (c) 10–12 p.m. (=3); or (d) after midnight (=4). Similarly, wake time was recorded in time slots: (a) before 6 a.m. (=1); (b) 6–8 a.m. (=2); (c) 8–10 a.m. (=3); and (d) 10 a.m. to noon (=4).

Next, sleep duration was calculated as: (wake time) – (bedtime), creating a unitless ordinal variable which reflects possible categorical ranges of sleep duration, as illustrated in Table S1. *Change in sleep duration* was coded as: (sleep duration in the pandemic) – (sleep duration before the pandemic), again creating a unitless ordinal variable with positive values indicating an increase in sleep, negative values indicating a decrease in sleep, and 0 corresponding to no substantial change. While change in sleep duration could range from −6 to 6, 100% of respondents fell between categories −3 to 3.

For tests comparing responses before versus during the pandemic, the Wilcoxon signed-rank test was applied and more specifically for: (a) bedtime/wake time by the three age groups, that is, 3–5 years old; 6–13 years old; and 14–17 years old; (b) sleep duration (for the whole sample and for North America, South America, Middle East, and Europe samples, separately); and (c) screen time by age group. Kruskal–Wallis nonparametric test was carried out to test samples from the four regions with the highest participation (North America, South America, Middle East, and Europe) regarding a change in sleep duration.

Logistic regression analyses were used to quantify the likelihood of a later bedtime/wake time during the pandemic relative to no change or earlier bedtime/wake time (dependent variable) for different age groups (14–17 years old or 6–13 years old relative to 3–5 years old reference) while adjusting for gender, number of siblings in the household, parents' marital status and education, and perceived income standing. Four models were tested, that is, two for weekdays and two for weekend.

Logistic regression analysis was also implemented to assess the association between the observed changes in sleep duration (dependent variable), and factors that parents reported as potentially affecting the sleep routine (explanatory variables), adjusting for covariates. One factor was introduced in each model: "more time on social media" (yes/no); "more time at home" (yes/no); "doesn't have to wake early" (yes/no); "less physical activity" (yes/no).

Due to missing data points, all regression analyses have been implemented using multiple imputation via chained equations (MICE) to impute missing values. This method assumes that data are missing at random and that the missingness can be modeled using the observed data. Because of the large number of missing observations for the sleep variables (~5%–20% missing), the model has run 20 imputations with a maximum of 50 iterations.[12,13] Imputation has been performed using predictive mean matching, which is a semi-parametric approach ensuring that the imputed values are plausible if the normality assumption is violated.[14,15] The results have been pooled for analysis.

3 | RESULTS

3.1 | Participants' demographic and socioeconomic characteristics

During the study period, a total of 1387 electronic surveys were initiated at the University of Missouri website and 863 (62.2%) were submitted with partially or fully completed responses. Eighteen questionnaires were excluded because respondents reported that the child did not sleep in the same home as the parent or did so only occasionally. Table 1 provides the demographic and socioeconomic characteristics of the 845 fully or partially completed questionnaires analyzed.

A great majority of responding parents were married (87.3%), had at least college degree (86.3%) and their perceived income status was either average (51.8%) or high/above average (39.1%). The relative frequency of response that household member was positive (symptomatic or asymptomatic) for SARS-CoV-2 was low (1.1%).

3.2 | Bedtime and wake time before and during the pandemic

Bedtime and wake time before and during the pandemic, on weekdays and weekends, according to age group are summarized in Tables 2 and 3. In all three age groups, bedtime was significantly later during the pandemic compared to before, both over the weekdays and weekends ($p < .01$). Similarly, in all age groups, wake time during the pandemic was later than before the pandemic ($p < .01$).

Of note, during the pandemic 23.1% of preschoolers, 46.2% of school-age children and 89.8% of adolescents were going to bed after 10 pm on weekdays, with these proportions being higher on weekends. Likewise, 42.5% of preschoolers, 61.3% of school-age children and 81.2% of adolescents were waking after 8 a.m. on weekdays, with these proportions being greater on weekends. Less than 4% of all responders reported earlier bedtime and wake times than before the pandemic.

During weekdays, 14- to 17-year-old children had threefold higher odds (OR 95% confidence interval [CI] = 1.66–5.44) for later bedtime and 5.55-fold higher odds (OR 95% CI = 3.19–9.64) for later wake time compared to the 3–5 years age group after adjustment for other confounding variables (Tables S2 and S3). During weekends, 14- to 17-year-old children had no significantly increased likelihood for later bedtime, but they had 2.65-fold greater odds (OR 95% CI = 1.56–4.51) for later wake time than the 3–5 years age group after adjustment for other covariates (Tables S4 and S5).

During weekdays, 6- to 13-year-old children had 1.68-fold higher odds (OR 95% CI = 1.17–2.42) for later bedtime and 2.33-fold higher odds (OR 95% CI = 1.65–3.29) for later wake time compared to the 3–5 years age group after adjustment for other covariates (Tables S2 and S3). During weekends, 6- to 13-year-old children had no significantly increased likelihood for later bedtime, but 1.91-fold higher odds (OR 95% CI = 1.29-2.83) for later wake time relative to the 3- to

TABLE 1 Demographic and socioeconomic characteristics of 845 survey respondents

	Percent	N
Sex		
Boy	50.2%	424
Girl	45.8%	387
Missing	4.0%	34
Age groups (years)		
3–5	29.3%	248
6–13	52.5%	444
14–17	13.6%	116
Missing	4.4%	37
Region of residence		
Asia	0.4%	3
Europe	15.5%	131
Middle East	28.2%	239
North America	35.5%	300
South America	14.1%	119
Oceania	0.6%	5
Missing	5.7%	48
Parent marital status		
Married	87.3%	738
Single	5.8%	49
Missing	6.9%	58
Perceived income status		
Low income	3.2%	27
Average	51.8%	438
High/above average	39.1%	330
Missing	5.9%	50
Parent education		
High school degree or less	6.3%	53
College graduate/MS/PhD	86.3%	729
Missing	7.4%	63
Someone in the household with COVID-19		
Yes	1.1%	9
No	93.3%	788
Missing	5.6%	48

TABLE 2 Bedtime before and during the pandemic according to age group

Bedtime	3–5 years old, *n* = 225	6–13 years old, *n* = 392	14–17 years old, *n* = 98
Weekdays			
6–8 p.m.			
Before	44.9% (101)	20.9% (82)	0% (0)
After	24% (54)	8.4% (33)	0% (0)
8–10 p.m.			
Before	48.0% (108)	69.7% (273)	42.9% (42)
After	52.9% (119)	45.4% (178)	10.2% (10)
10 p.m.-midnight			
Before	6.2% (14)	8.4% (33)	52.0% (51)
After	20.4% (46)	33.9% (133)	39.8% (39)
After midnight			
Before	0.9% (2)	1.0% (4)	5.1% (5)
After	2.7% (6)	12.3% (48)	50% (49)
p-values for bedtime comparisons before versus during the pandemic	<.01	<.01	<.01
Bedtime	**3–5 years old, *n* = 220**	**6–13 years old, *n* = 374**	**14–17 years old, *n* = 98**
Weekends			
6–8 p.m.			
Before	26.4% (58)	6.7% (25)	0% (0)
After	19.1% (42)	5.6% (21)	0% (0)
8–10 p.m.			
Before	58.6% (129)	52.9% (198)	9.2% (9)
After	50.0% (110)	35.6% (133)	3.1% (3)
10 p.m. midnight			
Before	13.2% (29)	35.1% (131)	52.0% (51)
After	25.9% (57)	41.4% (155)	29.6% (29)
After midnight			
Before	1.8% (4)	5.3% (20)	38.8% (38)
After	5.0% (11)	17.4% (65)	67.3% (66)
p-values for bedtime comparisons before versus during the pandemic	<.01	<.01	<.01

Note: Bedtime was coded as: (6–8 p.m.) = 1; (8–10 p.m.) = 2; (10–12 p.m.) = 3; (after midnight) = 4. Wilcoxon signed-rank test was applied for comparing bedtime before and during the pandemic by the three age groups. Counts in parentheses.

5-year-old children after adjustment for other confounding variables (Tables S4 and S5).

A higher number of children in the household was associated with significantly later bedtime in all days of the week ($p < .001$ on weekdays; $p = .01$ on weekends; Tables S2 and S4). A higher number of children in the household was associated with significantly later wake time during the weekdays ($p = .006$), but not during weekends ($p = .168$; Tables S3 and S5).

TABLE 3 Wake time before and during the pandemic according to age group

Wake time	3–5 years old, *n* = 242	6–13 years old, *n* = 424	14–17 years old, *n* = 106
Weekdays			
Before 6 a.m.			
Before	3.7% (9)	6.4% (27)	8.5% (9)
After	8.3% (20)	1.9% (8)	1.8% (2)
6–8 a.m.			
Before	84.7% (205)	88.7% (376)	81.1% (86)
After	49.2% (119)	36.8% (156)	17.0% (18)
8–10 a.m.			
Before	9.9% (24)	3.5% (15)	7.5% (8)
After	34.6% (84)	42.9% (182)	33.1% (35)
10 a.m. noon			
Before	1.7% (4)	1.4% (6)	2.8% (3)
After	7.9% (19)	18.4% (78)	48.1% (51)
p-values for wake time comparisons before versus during the pandemic	<.01	<.01	<.01
Wake time	**3–5 years old, *n* = 241**	**6–13 years old, *n* = 411**	**14–17 years old, *n* = 106**
Weekends			
Before 6 a.m.			
Before	3.3% (8)	2.4% (10)	1.9% (2)
After	7.5% (18)	1.9% (8)	0.9% (1)
6–8 a.m.			
Before	61% (147)	45.0% (185)	11.3% (12)
After	45.6% (110)	30.0% (123)	5.7% (6)
8–10 a.m.			
Before	32% (77)	46.7% (192)	50.9% (54)
After	36.9% (89)	41.9% (172)	27.4% (29)
10 a.m. noon			
Before	3.7% (9)	5.8% (24)	35.9% (38)
After	10.0% (24)	26.3% (108)	66.0% (70)
p-values for wake time comparisons before versus during the pandemic	<.01	<.01	<.01

Note: Wake time was coded as: (before 6 a.m.) = 1; (6–8 a.m.) = 2; (8–10 a.m.) = 3; (10 a.m. to noon) = 4. Wilcoxon signed-rank test was applied for comparing wake time before and during the pandemic by the three age groups. Counts in parentheses.

3.3 | Changes in sleep duration during the pandemic compared to before

As a result of the observed shift in bedtime and wake time, the median sleep duration score on weekdays increased significantly during the pandemic compared to before ($p < .001$), while there was no significant change during the weekend ($p = .51$; Table 4; top panel). More children had an increase in sleep duration on weekdays than a decrease, whereas similar proportions of children had an increase or a decrease on weekends (Table 4; top panel). Increase in sleep duration during the pandemic was most apparent in the 14–17 years age group during weekdays, while a decrease in sleep duration was most prominent in 3- to 5-year-old children during both weekdays and weekends. Sleep duration did not change in 43% of

TABLE 4 Change in sleep duration during the pandemic compared to before

All respondents	Decrease	No change	Increase	Missing	*p-values for sleep duration comparison before versus during the pandemic*
Weekdays	15.4% (130)	43.0% (363)	24.0% (203)	17.6% (149)	<.001 (↑duration)
Weekends	17.3% (146)	46.2% (390)	15.9% (134)	20.7% (175)	.51
Age (3–5) years	**Decrease**	**No change**	**Increase**	**Missing**	
Weekdays	21.4% (53)	49.2% (122)	18.1% (45)	11.3% (28)	.332
Weekends	20.2% (50)	55.6% (138)	10.9% (27)	13.3% (33)	.006 (↓duration)
Age (6–13) years	**Decrease**	**No change**	**Increase**	**Missing**	
Weekdays	13.7% (61)	46.8% (208)	25.2% (112)	14.2% (79)	<.001 (↑duration)
Weekends	17.8% (79)	43.9% (195)	19.4% (86)	18.9% (84)	.412
Age (14–17) years	**Decrease**	**No change**	**Increase**	**Missing**	
Weekdays	12.9% (15)	28.4% (33)	38.8% (45)	19.8% (23)	<.001 (↑duration)
Weekends	13.8% (16)	49.1% (57)	17.2% (20)	19.8% (23)	.442

Note: Change in sleep duration was coded as: (sleep duration in the pandemic) – (sleep duration before the pandemic) and ranged from −6 to 6 with positive values indicating an increase in sleep, negative values indicating a decrease in sleep, and 0 corresponding to no substantial change. Wilcoxon signed-rank test was applied for comparing sleep duration before and during the pandemic. Categorization of sleep duration is provided in Table S1. Counts in parentheses.

participants on weekdays and 46.2% on weekends. Children aged 14–17 years were the least likely to have unchanged sleep duration on weekdays (28.4%).

Sleep duration on weekdays increased significantly during the pandemic compared to before in children from North America and South America ($p = .026$ and $p < .001$, respectively), but not in participants from the Middle East and Europe (Table 5). Overall, there was no significant difference between the four regions regarding the change in sleep duration on weekdays ($p = .05$) or weekends ($p = .40$).

3.4 | Factors associated with changes in sleep duration

Children aged 14–17 years had approximately fourfold increased odds for increased sleep duration on weekdays when compared to 3- to 5-year-old children, after adjustment for household characteristics (Tables S6, S8, S10, and S12). Moreover, children aged 6–13 years had approximately twofold increased odds for increased sleep duration on weekends (Tables S7, S9, S11, and S13).

Screen time increased significantly in all age groups ($p < .001$; Table 6). Parental response "more time on social media" was significantly associated with decreased sleep duration on weekends ($p = .02$; Table S7) and "doesn't have to wake up too early in the morning" was related to increased sleep duration on weekends ($p < .01$; Table S9). "More time at home" was not associated significantly with sleep duration change ($p > .05$; Tables S10 and S11). "Less physical activity" was related to both increased ($p = .01$) and decreased ($p = .02$) sleep duration on weekends as compared to no change (Table S13), but not on weekdays (Table S12).

4 | DISCUSSION

This multicountry online survey confirms in part previous pediatric studies that have demonstrated increased sleep duration during the pandemic among geographically limited groups of children.[10,11] Although a shift of bedtime and wake times to later hours was identified as expected, in contrast to previous reports and for approximately half of children, sleep duration did not change, whereas for the rest of the respondent's sleep duration either increased or decreased. Furthermore, the current study expands on previously published research findings by examining bed/wake times and sleep duration by age cohorts. Most notably, 14- to 17-year-old participants were more likely than 3–5 years old to sleep longer on weekdays during the lockdown compared to before the pandemic, and 6- to 13-year-old children were more likely than 3–5 years old to sleep longer on weekends.

Additionally, explanations for sleep habit changes provided by parents were examined including "more time on social media", "doesn't have to wake-up early", "more time at home", and "less physical activity". Of note, the evaluated predictors were more often significant for the weekend, with "more time on social media" predicting decreased sleep duration, "doesn't have to wake up too early in the morning" increased sleep duration, and "less physical activity" during the weekend having a favorable effect on sleep duration for some children and unfavorable for others.

TABLE 5 Change in sleep duration during the pandemic compared to before by region

Region	Decrease	No Change	Increase	Missing	*P-values for sleep duration comparison before vs during the pandemic*
North America					
Weekdays	18.1% (44)	54.3% (132)	27.6% (67)	0% (0)	.026 (↑duration)
Weekends	18.5% (45)	58.0% (141)	21.4% (52)	2.1% (5)	.463
South America					
Weekdays	16.5% (19)	40.9% (47)	42.6% (49)	0% (0)	<.001 (↑duration)
Weekends	21.7% (25)	51.3% (59)	21.5% (27)	3.5% (4)	.907
Middle East					
Weekdays	19.6% (42)	56.1% (120)	24.3% (52)	0% (0)	.331
Weekends	20.1% (43)	57.9% (124)	14.5% (31)	7.5% (16)	.181
Europe					
Weekdays	19.8% (21)	50.0% (53)	30.2% (32)	0% (0)	.057
Weekends	26.4% (28)	48.1% (51)	20.75% (22)	4.7% (5)	.427

Note: Change in sleep duration was coded as: (sleep duration in the pandemic) – (sleep duration before the pandemic) and ranged from −6 to 6 with positive values indicating an increase in sleep, negative values indicating a decrease in sleep, and 0 corresponding to no substantial change. Wilcoxon signed-rank test was applied for comparing sleep duration before and during the pandemic. Categorization of sleep duration provided in Table S1. Counts in parentheses.

To promote sleep health, a regular schedule for wake time, outside activities and bedtime are recommended.[16] Moreover, electronic devices should be turned off at least 1 h before going to bed, because excessive screen time and exposure to blue light before bedtime are associated with poor sleep.[17] Surprisingly, in the cohort study from Italy by Pietrobelli et al.,[11] both sleep length and screen time in school age children and adolescents increased. Circadian misalignment, with delayed time going to bed and waking up, was also identified in another cohort of Italian mothers and their preschool-age children.[18] Increasing emotional symptoms and self-regulation difficulties in children were identified. Of interest, worse sleep among preschool children and their mothers was associated with worse children's inhibitory self-control.

In the present study, no information regarding virtual schooling was available since the majority of schools were operating at the time of the survey in partial attendance mode that varied from place to place and country to country. A minority of children and adolescents were going to bed early and waking up early. This finding may reflect either steady sleep habits or use of distance learning technology at home.

A national survey by Mitra et al.,[19] who was representative of Canadian children and youth with regard to geography, ethnicity, and age distribution showed an overall reduction in outdoor physical activity, sport, and play like walking and biking and increased indoor play and leisure screen time than before. Overall, children and adolescents spent more time sleeping and the sleep quality was unchanged.[8] Nevertheless, some groups of children and youth increased their healthy movement behaviors, possibly by using time that was available to them after school closures. Children and youth living in houses were more likely to have increased outdoor activity than those living in apartments. Living in high-density neighborhoods was another negative predictor of decreased healthy movement behavior during the pandemic.

Differential age-related effects of lockdown on sleep duration have also been demonstrated in an online questionnaire-based survey from India that was conducted to assess the impact of lockdown on the sleep-wake patterns in adults.[3] Both the average sleep onset and wake-up times were delayed by 38 ± 1.2 and 51 ± 1.2 min, respectively, during the lockdown compared to before lockdown.[3] However, during lockdown, significantly longer sleep duration was observed in the 18–24 years age group relative to their pre-lockdown state, without significant changes in the older age groups. The authors speculated that the pandemic unmasked sleep deficits related to the modern lifestyle and affecting primarily young people.

The favorable aspect of the lockdown on adolescents' sleep duration is analogous to the reported dramatic decrease in pediatric asthma-related Emergency Department visits in a Major Pediatric Center in the United States irrespective of the disease severity which was coincident with the COVID-19 pandemic.[20] This trend was attributed to less person-to-person transmission of respiratory viruses, reduced exposure to outdoor allergens and atmospheric air pollutants. Hence, in addition to the numerous inadvertent consequences accompanying the lockdown, it also helped to unmask unfavorable influences of the modern lifestyle on health.

In contrast to the results of this study, a high rate of insomnia ranging between 18% and 25% has been reported in Chinese

TABLE 6 Screen time before and during the pandemic according to age group

Screen time	3–5 years old, *n* = 244	6–13 years old, *n* = 428	14–17 years old, *n* = 109
Less than an hour			
Before	40.6% (99)	19.6% (84)	0% (0)
After	9.4% (23)	1.6% (7)	0% (0)
1–2 h			
Before	51.7% (126)	55.8% (239)	33.0% (36)
After	30.4% (74)	15.2% (65)	0.9% (1)
3–4 h			
Before	6.9% (17)	18.9% (81)	41.3% (45)
After	39.7% (97)	36.7% (157)	13.8% (15)
More than 4 h			
Before	0.8% (2)	5.7% (24)	25.7% (28)
After	20.5% (50)	46.5% (199)	85.3% (93)
p-values for screen time comparisons before versus during the pandemic	<.001	<.001	<.001

Note: Screen time was coded as: (less than an hour) = 1; (1–2 h) = 2; (3–4 h) = 3; (more than 4 h) = 4. Wilcoxon signed-rank test was applied for comparing screen time before and during the pandemic by the three age groups. Counts in parentheses.

adolescents and young adults during the pandemic.[21] Anxiety and depression were positive predictors of the presence of insomnia. Nevertheless, no data on the prevalence of insomnia before the pandemic were presented.

In our survey, we have also noted a higher proportion of preschool age children with decreased sleep duration on weekdays and weekends compared to older children, but this relationship was not significant in multivariable analysis. Similarly, in a small cohort (*n* = 47) of preschool-age children whose mothers completed an online questionnaire for a period of 30 consecutive days, sleep duration initially decreased and then stabilized at a lower level compared before the pandemic.[22]

A limitation of many published studies on the effects of COVID-19 is the inclusion of mostly subjects with high socioeconomic status and education level.[2,19,23] Results of the present study may have been affected by the fact that most participating parents were at least of average or high socioeconomic or educational status. Targeted exploration of the impact of lockdown measures and home-based virtual schooling among underserved communities should therefore actively pursued.

In conclusion, this multicountry survey identified a shift of bedtime and wake times to later hours with unchanged sleep duration for half of them, and either increased or decreased sleep length for the rest of them. While 14- to 17-year-old participants were more likely to sleep longer on weekdays during the lockdown period compared before the pandemic and 6- to 13-year-old children were more likely to sleep longer on weekends, there was a trend for shorter sleep length in preschool children. Changes observed in adolescents may suggest concealed sleep deficits.

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CONFLICT OF INTERESTS

The authors declare that there are no conflict of interests.

AUTHOR CONTRIBUTIONS

Athanasios G. Kaditis: Data curation (equal); formal analysis (equal); investigation (equal); writing manuscript & editing (equal). **Adrienne Ohler**: Data curation (equal); formal analysis (lead); editing manuscript (equal). **Alex Gileles-Hillel**: Investigation (equal); methodology (equal); editing manuscript (equal). **Shoham Choshen-Hillel**: Methodology (equal); editing manuscript (equal). **David Gozal**: Conceptualization (equal); data curation (equal); editing manuscript (equal). **Oliviero Bruni**: Investigation (equal); editing manuscript (equal). **Secil Aydinoz**: Investigation (equal); editing manuscript (equal). **Rene Cortese**: Investigation (equal); editing manuscript (equal). **Leila Kheirandish-Gozal**: Conceptualization (lead); data curation (lead); investigation (lead); methodology (lead); project administration (lead); supervision (lead); editing manuscript (lead).

ORCID

Athanasios G. Kaditis https://orcid.org/0000-0003-3592-0037
Alex Gileles-Hillel https://orcid.org/0000-0002-0656-905X
David Gozal https://orcid.org/0000-0001-8195-6036
Oliviero Bruni https://orcid.org/0000-0003-2207-1398

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SUPPORTING INFORMATION

Additional Supporting Information may be found online in the supporting information tab for this article.

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