


REVIEW ARTICLE

Effects of the COVID-19 pandemic on sleep quality in children and adolescents: A systematic review and meta-analysis

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Summary

We synthesise the literature on the potential influence of the COVID-19 pandemic on sleep quality in children and adolescents. The search identified studies that examined the relationship between sleep quality and disorders during the COVID-19 pandemic. It began in May 2021 and has had two updates with the last in January 2022. The databases used were LILACS, PubMed, and EMBASE. Random effects models were performed to explore heterogeneity between studies. Data were presented as continuous variables (mean value and standard deviation) to perform a meta-analysis. Twenty-nine studies from 16 countries were identified: Nine had children and eight had adolescents. The overall quality of the studies ranged from high (27.6%) to medium (65.5%) and low (6.9%). Eight studies were eligible for meta-analysis. There was an increase in sleep duration during the pandemic when compared with the previous period 0.33 (95%CI -0.07 ; 0.60) ($p < 0.001$) and late bedtime 0.78 (95%CI -0.33 ; 1.22) ($p < 0.001$). A trend toward reduced sleep efficiency was also detected 0.54 (95%CI -0.75 ; -0.33) $p = 0.20$. Parents' reports of increased use of screen media/electronic devices were associated with worse sleep quality. The results suggest an influence of the pandemic on sleep characteristics such as increased sleep duration, late bedtimes, and poor sleep quality. These alterations were related to changes in family routines during this period.

KEYWORDS

adolescents, children, COVID-19, pandemic, sleep

1 | INTRODUCTION

The World Health Organization (WHO) declared a pandemic caused by the new SARS-Cov-2 virus in March 2020. The virus has high transmissibility, and the disease caused by the virus was named COVID-19 (WHO, 2020). To prevent rapid spread, measures were introduced to contain the disease such as the use of protective masks and, crucially, social isolation. The isolation imposed by the COVID-19 pandemic included schools and affected children and teenagers who were confined to their homes with the option for online education (Alvarez et al., 2020).

Unexpected and prolonged disruptions of normal school routines, daily activities, and social connections can represent an important risk factor for the physical and mental health of children and adolescents. There was decreased overall well-being because isolation increases stress levels, and these changes impact daily activities as well as sleep patterns (Guo et al., 2021).

During the first wave of the COVID-19 pandemic, school closures had negative effects on the health habits of school children including less physical activity, increased screen exposure, and irregular sleep patterns (Guo et al., 2021). A literature review and meta-analysis with children conducted in other databases (and in a period that differed

from our review) briefly revealed that the prevalence of sleep disorders in children was 54% and the worsening of sleep quality was 27% during the first wave (Sharma et al., 2021).

Good quality sleep is essential for good health because it acts directly on neuronal, cognitive, immune, and proper growth/development (El Halal & Nunes, 2019). Significant changes in routine during confinement including unrestricted sleep schedules, worse sleep quality, more flexible sleep/wake schedules, prolonged daytime naps, increased screen exposure, decreased daylight exposure, reduced physical activity, increased sedentary behaviours, reduced social interactions, as well as increased stress and anxiety contributed to unhealthy sleep patterns and sleep disorders (Sharma et al., 2021). Thus, this study aimed to synthesise the literature on the potential influence of pandemic COVID-19 on sleep quality in children and adolescents, and, when possible, quantified the relationship through a meta-analysis approach.

2 | METHODS

2.1 | Search strategy

The search strategy was designed to identify studies that examined the relationship between sleep disorders, sleep quality, sleep duration, efficacy, and sleep time. The literature search was conducted by two authors independently (SR, MN) using the search engines LILACS, PubMed, and EMBASE. Articles were searched from 2020 to 2021. The search began in May 2021 and had two data search updates: The first in August and the second in January 2022.

The search terms were sleep, COVID-19, children, adolescents, and their synonyms according to Mesh terms (for PubMed and LILACS databases) and Entree terms for the Embase database. The search key can be found in Table S1. The detailed search strategy is described in Figure 1. The Preferred Reporting Items for Systematic Reviews and Meta-analysis Guidelines (PRISMA) were followed during this study. The study was registered on the PROSPERO platform using the registration number CRD42021208144 (Page et al., 2021).

2.2 | Inclusion criteria and screening review

To screen the studies, three trained researchers independently reviewed titles and abstracts (CF, LS, NF), and a fourth researcher analysed disagreements (SR); a consensus meeting was held when necessary. The inclusion criteria were: (1) full articles, cross-sectional, case-control, clinical trials, and cohort studies; (2) studies investigating sleep in children and adolescents during the COVID-19 pandemic period; (3) studies including children as part of a larger study population if separate details were available for children and adolescents; (4) articles in English, Spanish, and Portuguese were included. Exclusion criteria included any type of literature review, animal studies, qualitative studies, case reports, letters to the editor, editorials, and event proceedings; duplicate studies were chosen. In addition, studies that focussed

on patients with different medical diseases or neurobehavioural disorders were excluded. In the article-selection step, Rayyan software was used to ensure selection in an independent manner.

2.3 | Data extraction

Three researchers (SR, CF, LS) extracted the data independently; additional discussions and consensus meetings resolved the differences. An Excel spreadsheet was created for extraction where relevant data included the first author's last name, article title, year of publication, number of participants (sample, mean age, diagnostic criteria used for sleep disorders, comorbidities, inclusion and exclusion criteria for participants, and continuous medication use). The study design evaluated the methods used to assess sleep disorders (validated or non-validated questionnaire or diagnostic use), methods used to assess sleep duration, sleep quality, and sleep disorders (single survey item, validated questionnaire, diary, actigraphy, or polysomnography).

2.4 | Sleep quality measures

The National Sleep Foundation recommendations were used to define sleep duration and sleep efficiency (Hirshkowitz et al., 2015; National Sleep Foundation, 2020). Sleep duration was tracked according to each age group of children and adolescents (Hirshkowitz et al., 2015). Sleep efficiency was considered ideal at $\geq 85\%$ (National Sleep Foundation, 2020).

The unit used to measure sleep duration was hours, and the information was reported by parents. Bedtime was also reported by parents, and the mean time was calculated for each study. Studies that did not report the number of hours of sleep duration or bedtime were not included in the meta-analyses.

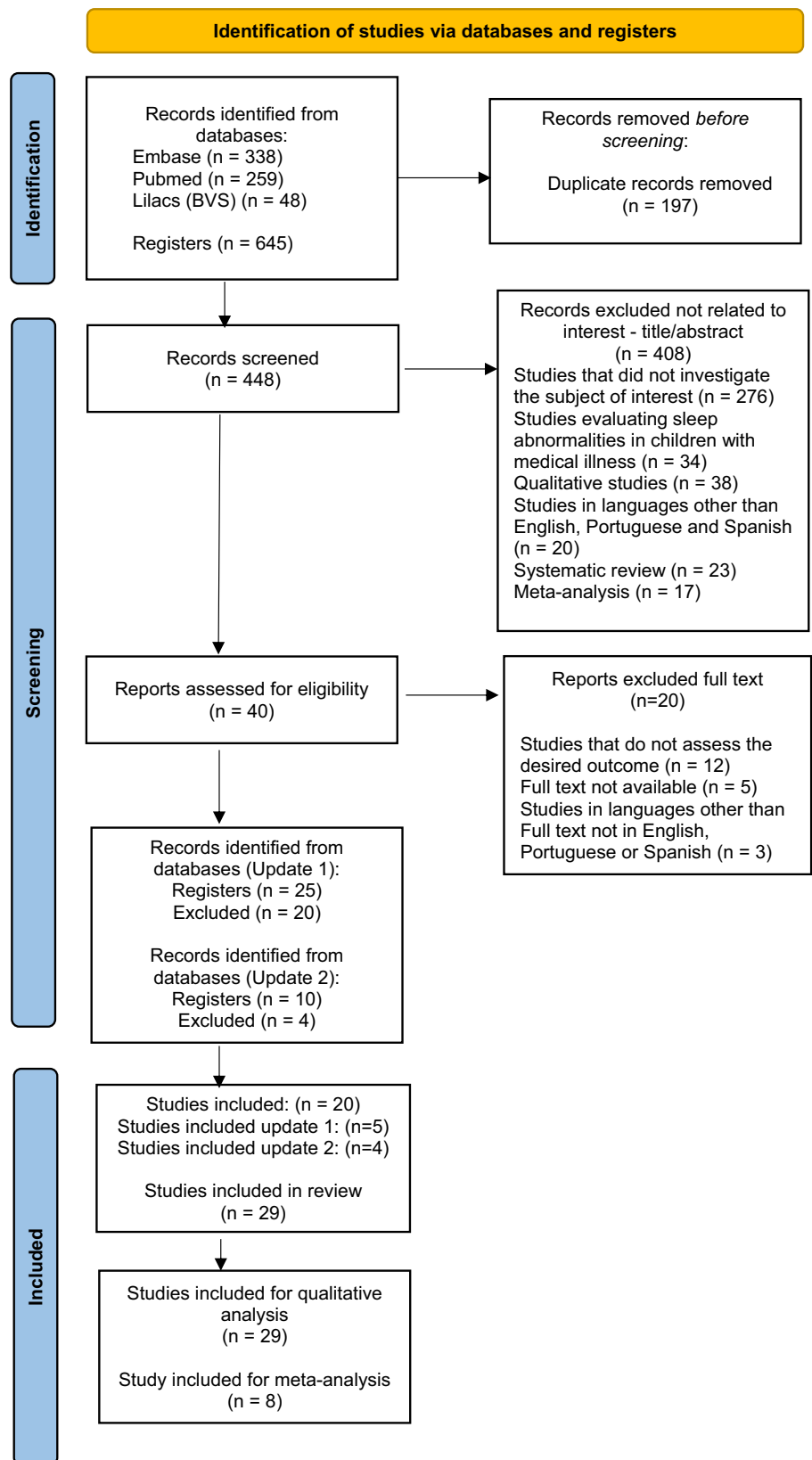
2.5 | Use of electronics devices and sleep

The use of electronics during the lockdown of the COVID-19 pandemic was measured in the studies and the sleep changes of children and adolescents were correlated. The results were presented descriptively in our study while addressing screen usage and screen time.

2.6 | Methodological quality of the included studies and publication bias

Two authors independently assessed study quality (CF, LS) using the National Institute of Heart, Lungs and Blood (NHLBI) - Study Quality Assessment Tools standardised criteria for the Quality Assessment Tool for Study Quality Observational Cohort and Cross-Sectional Study. This, tool consists of 14 questions that rate studies as bad, fair,

FIGURE 1 Flowchart selection of articles according to the PRISMA model



or good (NHLBI, 2021). Any disagreement between the two authors in the review was resolved by discussion with the third author (SR). The quality assessments of the studies are detailed in Table 1; there were eight high quality studies.

2.7 | Data synthesis and statistical analysis

Random effects models were performed to explore heterogeneity among the expected studies. The analyses were performed using R

TABLE 1 Summary of included studies of sleep in children and adolescents during the COVID-19 pandemic

Author N°	Year	Country	Time of the study	Number of participants	Age of participants (years)	Scales for sleep	Study design	Sleep measurement result ^a	Results	Quality study
1 Aguilar-Farías N et al. ^c	2020	Chile	30 March to 27 April 2020	3157	1–5	Likert scale 3	Prospective, cross-sectional	-Sleep quality ↓ -Sleep duration ↑	Sleep quality worsened in children with higher family incomes and less crowded homes Boys - before COVID-19 10.86 h; during COVID-19 10.99 h Girls - before COVID-19 10.97 h; during COVID-19 11.02 h	Good
2 Silva LCB et al.	2020	Brazil	27 May to 5 June 2020	120	5–10	Instrument elaborated by 15 researchers from UFAL and UFRPE	Cross-sectional	-Sleep duration ↑	Increase in sleep duration of 10% $p < 0.05$	Poor
3 Komada Y et al. ^c	2021	Japan	June 2019 to January 2020	651	1–5	Paediatric Daytime Sleepiness Scale (PDSS-J)	Longitudinal, cross-sectional	-Sleep duration ↑	Increased sleep duration during weekdays: 9.09 h to 9.16 h	Good
4 Liu Z et al.	2021	China	17 and 19 February 2020	1619	4–6	Children's Sleep Habit Questionnaire (CSHQ)	Prospective, cross-sectional	-Sleep duration ↑ -Prevalence of sleep disturbance ↓	Sleep duration during 2018 (9.47 h) and in 2020 (10.38 h) The proximity of the family and the lack of concern with the school routine made them have less general sleep disorders	Fair
5 Abid R et al. ^c	2021	Tunisia	24 April to 10 May 2020	100	5–12	- Pittsburgh Sleep Quality Index (PSQI) - Ricci and Gagnon sedentary behaviour questionnaire	Prospective, cross-sectional	-Sleep quality ↓ -Prevalence of sleep disturbance ↑	Poor sleep quality by the PSQI global score ($p = <0.01$) Increase in sleep disorders ($p = 0.016$)	Good
6 Markovic A et al.	2021	Germany, France, Italy and Spain	(April 2020) and follow-up assessments (May and June 2020)	452 babies and 412 preschool children	Babies (0–3 years) preschool children (3–6 years)	- Brief Infant Sleep Questionnaire (BISQ) - Children's Sleep Habits Questionnaire	Longitudinal, cross-sectional	-Sleep quality ↓ -Sleep duration ↑	There was poor sleep quality in the first sample, but in the second sample, this effect practically disappeared Increased sleep duration by 53 minutes during COVID-19	Fair

TABLE 1 (Continued)

N°	Author Children	Year	Country	Time of the study	Number of participants	Age of participants (years)	Scales for sleep	Study design	Sleep measurement result ^a	Results	Quality study
7	Alonso-Martínez AM et al. ^c	2021	Spain	(September to December 2019) and second evaluation March to April 2020)	268	4–6	Child self-regulation and behaviour questionnaire (CSBC)	Longitudinal, cross-sectional	-Sleep duration ↑	Sleep duration increased during COVID-19, before COVID-19 9.51 h, during COVID-19 9.54 h	Good
8	Cellini N et al. ^c	2021	Italy	1 April to 9 April 2020	299	6–10	- Pittsburgh Sleep Quality Index (PSQI) - Sleep disturbance scale for children (SDSC)	Cross-sectional	-Sleep quality ↓ -Sleep duration ↑	Poor quality during COVID-19 $p < 0.001$ Sleep duration increased during COVID-19. Before COVID-19 9.73 h, during COVID-19 10.21 h	Good
9	Ghanamah R et al. ^c	2021	Israel	4 December to 10 December 2020	382	5–11	Questionnaire designed by the researchers	Cross-sectional	-Sleep duration ↑	Sleep duration increased during COVID-19. Before COVID-19 8.58 h, during COVID-19 9.17 h	Good
10	Bacaro V et al.	2021	Italy	14 April to 10 May 2020	2361	0–12	Questionnaire designed by the researchers	Cross-sectional	-Prevalence of sleep disturbance ↑ (insomnia)	It was observed that bedtime was later (>9 p.m.) and 59.4% of children had at least one clinical diagnostic criterion for childhood insomnia	Fair
11	Zreik G et al.	2020	Israel	From 20 to 30 April 2020	264	0.5–6	- Insomnia Severity Index (ISI) - Brief Infant/Child Sleep Questionnaire - Trait Anxiety Scale - COVID-19 acute anxiety	Cross-sectional, prospective	-Sleep duration ↑	Sleep duration increased during COVID-19. During COVID-19 10.20 h	Fair
12	Dondi A et al.	2021	Italy	1 September to 15 October 2020	6210	0–10	- Questionnaire designed by the researchers, with some items of the Sleep disturbance scale for children (SDSC)	Cross-sectional	-Prevalence of sleep disturbance ↑	Increased sleep disturbances related to falling asleep, sleep maintenance and night terrors/nightmares	Fair

(Continues)

TABLE 1 (Continued)

N°	Author Children	Year	Country	Time of the study	Number of participants	Age of participants (years)	Scales for sleep	Study design	Sleep measurement result ^a	Results	Quality study
Children and Adolescents											
1	Lavigne-Cerván R et al.	2021	Spain	April to 10 May 2020		6–18	- Screening for sleep disorders in childhood	Prospective, cross-sectional	-Sleep quality ↓	According to the BEARS scale score, it showed poor sleep quality when compared with anxiety	Fair
2	Fidanci I et al.	2021	Turkey	September to December 2020	114	6–16	Sleep Disturbance Scale for Children (SDSC)	Prospective, cross-sectional	-Sleep quality ↓	The SDSC score showed that girls have worse sleep quality ($p < 0.05$) than boys	Poor
3	Bruni O et al.	2021	Italy	7 May to 15 June 2020	4314	1–18	Sleep Disturbance Scale for Children (SDSC)	Prospective, cross-sectional	-Sleep quality ↓ -Sleep duration ↑ -Prevalence of sleep disturbance ↑	Adolescents had better sleep quality than younger children Sleep duration increased during the pandemic mainly in the 4–18 age group, younger children did not experience a significant increase Younger groups had a higher prevalence of sleep disorders such as falling asleep and bedtime anxiety (1–12 years)	Fair
4	Köken OU et al.	2021	Turkey	June 2020 and August 2020	116	6–16	Sleep Disturbance Scale for Children (SDSC)	Prospective, cross-sectional	-Prevalence of sleep disturbance ^b	Regarding the period collected, there was no significant result in the SDSC score, showing that there was no difference between before and during COVID-19	Fair
5	Kaditis AG et al.	2021	USA	1 May to 10 June 2020	845	3–17	Questionnaire designed by the researchers	Cross-sectional	-Sleep duration ↓ ↑	In the age groups (6–17) sleep duration increased ($p = <0.01$) and in the age group (3–5) the duration decreased during weekends	Fair
6	Adibelli D et al.	2021	Turkey	30 March and 20 April 2020	597	7–13	Generic health-related quality of life questionnaire for children (Kid-KINDL)	Longitudinal, cross-sectional	-Sleep quality ↓	Sleep quality worsened due to the tendency to sleep increased by 34.2% during COVID-19	Fair

TABLE 1 (Continued)

N°	Author Children	Year	Country	Time of the study	Number of participants	Age of participants (years)	Scales for sleep	Study design	Sleep measurement result ^a	Results	Quality study
7	Wearick-Siva et al.	2021	Brazil	27 April and 30 July 2020	2484	0–18	- Pittsburgh Sleep Quality Index (PSQI) - Epworth Sleepiness Scale - Brief Infant Sleep Questionnaire (BISQ) - Sleep Disturbance Scale for Children (SDSC)	Cross-sectional	- Sleep quality ↓ - Sleep duration ↑	Poor sleep quality occurred in children: 58.6% in children aged 0–3 years; 33.9% in children aged 4–12 years and 56.6% in adolescents aged 13 to 18 years Sleep duration only 30.7% of children aged 0–3 years slept <9 h	Fair
8	Dutta K et al.	2020	India	For 2 weeks from 26 April (after a month of commencement of lockdown) in India	153	8–16	- Questionnaire designed by the researchers - Epworth Sleepiness Scale	Cross-sectional	- Sleep quality ↓ - Sleep duration ↑	Sleep quality worsened by 42.96% Increased sleep duration during COVID-19 from 08:09 h	Fair
9	Uccella S et al.	2021	Italy	23 March and 4 April 2020	3245	0–18	Questionnaire designed by the researchers, with some items of the Sleep	Cross-sectional	- Prevalence of sleep disturbance ↑	Children <6 years (19%) with nocturnal awakenings and difficulties falling asleep. In children and adolescents (6–18 years), they had difficulty falling asleep (48.6%) and waking up (33.2%)	Fair
10	Lim MTC et al. ^c	2021	Singapore	7 April 2020 to 1 June 2020	593	3–16	Questionnaire designed by the researchers	Cross-sectional	- Sleep duration ↑	Sleep duration increased by 0.35 h in teens during COVID-19	Good
Adolescents											
1	Genta FD et al.	2021	Brazil	15 March 2019 and again from 19 to 27 June 2020	193	16.4 ± 1.1 years	- Pittsburgh Sleep Quality Index (PSQI) - Epworth Sleepiness Scale - Horne-Osteberg Morningness-Eveningness Questionnaire (MEQ)	Longitudinal, cross-sectional	- Sleep quality ↑ - Sleep duration ↑	Sleep duration increased and sleep quality (PSQI) improved only among adolescents with shorter sleep duration before the pandemic	Fair

(Continues)

TABLE 1 (Continued)

N°	Author Children	Year	Country	Time of the study	Number of participants	Age of participants (years)	Scales for sleep	Study design	Sleep measurement result ^a	Results	Quality study
2	Ranjbar K et al.	2021	Iran	14 to 31 March 2020	2697	13.76 ± 2.50	Questionnaire designed by the researchers	Longitudinal, cross-sectional	-Sleep duration ↑	53.5% adolescents had more than 12 hours of sleep	Fair
3	Zhou SJ et al.	2021	China	8 to 15 March 2020	11,835	12–29	- Pittsburgh Sleep Quality Index (PSQI) - Patient Health Questionnaire (PHQ-9) - Generalised Anxiety Disorder (GAD-7)	Longitudinal, cross-sectional	-Sleep quality ↓ -Sleep duration ↑ -Prevalence of sleep disturbance ↑	Poor sleep quality in college students (12.6%) than compared with high school (7.1%) and high school students (10.5%) Sleep duration was worse in high school students (50.1%) 23.2% of adolescents had a prevalence of insomnia	Fair
4	Shujuan L et al.	2021	China	Wave 1 - December 2019 (before the pandemic), and Wave 2 - July 2020 (during the pandemic)	2496	11–16	Center of Epidemiological Studies Depression Scale for Children (CES-DC)	Longitudinal, cross-sectional	-Sleep duration ↓	Short sleep duration in adolescents was associated with the likelihood of depressive symptoms ($p = < 0.001$)	Fair
5	Socarras LR et al. ^c	2021	Canada	3 June to 3 July 2020	498	12–25	Pittsburgh Sleep Quality Index (PSQI)	Prospective, cross-sectional	-Sleep duration ↑	Sleep duration increased during the weekday by 1 h and 13 min and 31 min during the weekends during COVID-19	Good
6	Windiani IGAT et al.	2021	Indonesia	August 2020	243	15–18	Pittsburgh Sleep Quality Index (PSQI)	Cross-sectional	-Sleep duration ↓ -Prevalence of sleep disturbance ↑	Sleep duration during COVID-19 lockdown was lowest at <8 h (62.9%) 30.4% of adolescents had sleep disorders	Fair
7	Lu C et al.	2020	China	13 and 20 May in 2020	965	Mean 15.26	- Youth Self-Rating Insomnia Scales (YSIS) - Generalised Anxiety Disorder scale (GAD-7)	Cross-sectional	-Prevalence of sleep disturbance ↑	The prevalence of insomnia in adolescents increased by 34.9% during COVID-19	Fair

^aDistribution of results: ↓ decreased; ↑ increased; ↓↑ decreased and then increased.

^bNo difference with before and during COVID-19.

^cStudies selected for the meta-analysis.

Studio software. Data of interest are presented as continuous variables (mean value and standard deviation) and were used to perform a meta-analysis to obtain the mean difference (MD) and 95% confidence interval (CI). The results were calculated using standardised mean difference (SMD). Sensitivity was analysed by determining whether excluding one study at a time significantly changes the heterogeneity of the results and quality. Heterogeneity between studies in each analysis was assessed by the Q-Cochran test to measure significance and by the I² statistic to measure magnitude. Heterogeneity was considered substantial for I² statistic values equal to or greater than 50%; we adopted a significance level of $p \leq 0.05$.

3 | RESULTS

There were 645 articles identified that included the study terms; 197 were duplicates, thus resulting in 448 articles for title and abstract review. Another 408 were excluded for not meeting the inclusion criteria. Therefore, 40 articles were subjected to full text review with discussion in consensus meetings. Of these 40 articles, 20 were excluded leaving 20 articles for extraction. Two updates were then performed; five articles were included in the first and four in the second. The overall quality of the studies was 27.6% with high quality, 65.5% with medium quality, and 6.9% with low quality. Eight studies were eligible for meta-analysis. Importantly, the use of the term COVID-19 and its synonyms makes the strategic search sensitive due to the term being widely published from 2020 to 2022.

Studies were analysed using the NHLBI, and scores set at (0–6 points for low quality studies) (7–9 points for medium quality studies), and (10–14 points for high quality articles). The items evaluated were: (a) study objective; (b) study population size; (c) 75% participation rate; (d) recruitment of the study population (whether similar or not); (e) sample size (a minimum of 300 was set); (f) assessment of the exposure of interest; (g) time between an exposure (measured as a continuous variable or by exposure category); (h) whether exposure measures were clearly defined; (i) whether exposure measures were assessed more than once over time (minimum 6 months); (j) outcome measures were clearly defined; (k) whether there was blinding of participants in the exposure (not applicable because the exposure was block exposure); (l) loss to follow-up after baseline was 20% or less; and (m) confounding variables were measured and adjusted for (Table 1).

3.1 | Sleep quality in children during the COVID-19 pandemic

The search strategy used to measure sleep quality was questionnaires made available online. The choice of questionnaires varied from study to study, and this phenomenon likely contributed to the high heterogeneity of the results.

The Sleep Disorders Scale for Children (SDSC) was used in six studies and was the most commonly used measure in the studies

found. On the SDSC scale, studies point to a worsening of sleep quality during the COVID-19 pandemic; in addition, children had sleep initiation and maintenance disorders (Bruni et al., 2022; Cellini et al., 2021; Dondi et al., 2021; Wearick-Silva et al., 2022). There was only one study in which there was no significant difference in sleep quality, which may be justified by the fact that the study did not have a comparison before and during the pandemic because the study compared melatonin levels in children with or without COVID-19 (Köken et al., 2021).

Two studies evaluated children using the Brief Infant Sleep Questionnaire (BISQ). This study found that younger children (0–3 years old) experienced longer sleep latency, delayed bedtime, and reduced sleep duration during confinement compared with older children (3–6 years old) during COVID-19 isolation (Markovic et al., 2021). The second study showed that 58.6% of the children aged (0–3 years) experienced worse sleep quality, and 39.4% of the children experienced nocturnal awakenings in agreement with the first study (Silva et al., 2022).

Other scales were used to measure sleep quality such as the Children's Sleep Habit Questionnaire (CSHQ) (Liu et al., 2021) and Epworth Sleepiness Scale (ESS) (Dutta et al., 2022); other studies used questionnaires produced by the authors (Bacaro et al., 2021; Ghanamah & Eghbaria-Ghanamah, 2021). Regardless of the sleep quality scale, we note that the studies pondered a worse quality of sleep when associated with the period of isolation due to the COVID-19 pandemic than in previous periods investigated.

3.2 | Sleep quality of adolescents during the COVID-19 pandemic

The quality of sleep of adolescents was measured through questionnaires made available online. The Pittsburgh Sleep Quality Index (PSQI) scale was used in five studies and was the most commonly used scale in adolescents. Three studies found that sleep quality worsened during the COVID-19 pandemic (Silva et al., 2022; Windiani et al., 2021; Zhou et al., 2020). Two studies pointed to an increased prevalence of sleep disturbances (Windiani et al., 2021; Zhou et al., 2020), and four studies showed an increase in sleep duration during COVID-19 in adolescents (Genta et al., 2021; Silva et al., 2022; Windiani et al., 2021; Zhou et al., 2020).

The second most-used sleep quality measurement scale for adolescents was the Sleep Disturbance Scale for Children (SDSC) with three studies (Bruni et al., 2022; Fidancı et al., 2021; Köken et al., 2021). Two studies showed a worsening in the adolescents' sleep quality (Bruni et al., 2022; Fidancı et al., 2021), and one study showed an increase in sleep duration (Bruni et al., 2022) as shown in Table 1.

Adolescents had better sleep quality and longer sleep duration than children (Bruni et al., 2022; Kaditis et al., 2021). Regarding bedtime, adolescents went to sleep later during the isolation of COVID-19 ranging from 10:00 p.m. to midnight (Lim et al., 2021; Ranjbar et al., 2021; Socarras et al., 2021). During the pandemic, an increase in

cases of insomnia among adolescents was reported: one study found a 23.2% prevalence of insomnia cases (Zhou et al., 2020).

Other measurement scales were used to measure sleep quality such as Generac Health-related Quality of Life Questionnaire for Children (Kid-KNIDL) (Adibelli & Sümen., Adibelli & Sümen, 2020), Epworth Sleepiness Scale (ESS) (Dutta et al., 2022; Genta et al., 2021; Silva et al., 2022), Horne-Osteberg Morningness-Eveningness Questionnaire (MEQ) (Genta et al., 2021), Patient Health Questionnaire (PHQ-9) (Zhou et al., 2020), Generalised Anxiety Disorder (GAD-7) (Lu et al., 2020; Zhou et al., 2020), Screening for Sleep Disorders in Childhood (Lavigne-Cerván et al., 2021), Center of Epidemiological Studies Depression Scale for Children (CES-DC) (Liao et al., 2021), Youth Self-Rating Insomnia Scales (YSIS) (Lu et al., 2020), and five studies used questionnaires developed by the authors (Dutta et al., 2022; Kaditis et al., 2021; Lim et al., 2021; Ranjbar et al., 2021; Uccella et al., 2021). In fact, adolescents benefited more from social isolation during the pandemic than children in relation to sleep because they had longer sleep duration, but this phenomenon did not predominate in sleep quality and the prevalence of sleep disorders versus prior periods (Bruni et al., 2022).

3.3 | Parents' sleep quality and relationship with their children

Three studies evaluated the sleep of parents during the COVID-19 pandemic. During the COVID-19 pandemic, parents with children who had sleep disorders had worse sleep quality (Silva et al., 2022). However, another study found that even parents with children without sleep disorders had more difficulty sleeping (Genta et al., 2021). Another study identified increased maternal insomnia and anxiety during the COVID-19 pandemic (Zreik et al., 2021). This may be because mothers in fear of COVID-19 had worse sleep quality just as emotional symptoms increased during confinement (Cellini et al., 2021).

3.4 | Increased use of electronics and the impact on children and adolescents' sleep

Regarding the use of electronic devices, eight studies reported an increase during the pandemic with an association with sleep (Abid et al., 2021; Aguilar-Farias et al., 2021; Dutta et al., 2022; Liu et al., 2021; Ranjbar et al., 2021; Silva et al., 2020; Windiani et al., 2021). An increase of 3.05 h of electronic use was observed during COVID-19; before the pandemic the average time was 1.66 h. Another study found that the increase was 36% in children. There has been increased use of electronics on both weekdays and weekends during the COVID-19 pandemic lockdown (Aguilar-Farias et al., 2021; Dutta et al., 2022; Silva et al., 2020).

The increased use of electronics resulted in decreased physical activity, and consequently worsened sleep quality (Abid et al., 2021). There was an increase in the prevalence of sleep disorders associated

with the use of electronic devices: one of the studies found that 33.1% of the children with some type of sleep disorder used electronic devices during COVID-19 (Ghanamah & Eghbaria-Ghanamah., Ghanamah & Eghbaria-Ghanamah, 2021; Windiani et al., 2021). Parental education regarding the use of electronic devices by their children proved to be relevant during the pandemic because parents at high economic levels have children who tend to use screens more frequently (Aguilar-Farias et al., 2021).

3.5 | Meta-analysis

Eight studies were eligible for meta-analysis. Here, sleep quality was measured based on sleep duration, sleep efficiency, and later bedtime. Sleep duration was higher when comparing the pandemic and pre-pandemic periods SMD 0.33 (95%CI -0.07; 0.60) ($p < 0.001$) (Figure 2) (Abid et al., 2021; Aguilar-Farias et al., 2021; Alonso-Martínez et al., 2021; Komada et al., 2021; Lim et al., 2021; Socarras et al., 2021). Two studies reported a trend toward decreased sleep efficiency, but the results were not statistically significant SMD -0.54 (95%CI -0.75; -0.33) ($p = 0.20$) (Figure 3) (Abid et al., 2021; Alonso-Martínez et al., 2021). Later bedtime was another significant finding SMD 0.78 (95%CI -0.33; 1.22) ($p < 0.001$) (Figure 4) (Cellini et al., 2021; Komada et al., 2021; Liao et al., 2021; Lim et al., 2021).

4 | DISCUSSION

This systematic review of the literature analysed the data describing the impact of the COVID-19 pandemic on the sleep quality of children and adolescents. A worsening in sleep quality resulting from the abrupt change in routine caused by the pandemic lockdown was observed for both children and adolescents. It is important to emphasise that our review found studies from 16 different countries, and of course the isolation or lockdown measures did not follow the same pattern. They changed depending on different periods of virus transmission. We thus considered the first and second wave of SARS-Cov-2 transmission. Some countries initially implemented lockdown measures for 10 days and then extended them for 20 days as the pandemic progressed; isolation measures were then relaxed (Alfano & Ercolano, 2020).

With the change in routine, especially school routine, school-aged children were found to have more impairments to their sleep habits. The lack of commuting to school and the adaptation to virtual classrooms allowed children to sleep more, which may have impacted bedtime, that is, children went to sleep later than their expected usual time (Alvarez et al., 2020; Silva et al., 2020).

Parents claimed that school-aged children slept more in the morning and were less tired in the afternoon and did not nap during the day. It is likely that there was more flexibility in bedtime, thus allowing them to wake up later. This sleep pattern is usually observed during vacation periods and weekends (Becker et al., 2021; Okely et al., 2021; Santos & Louzada, 2022). The consequences of sleeping

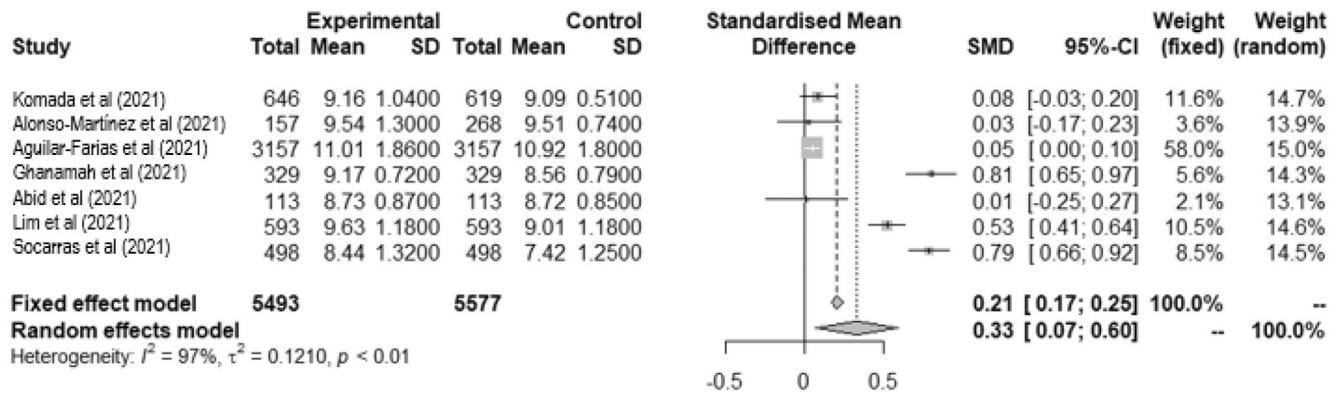


FIGURE 2 Forest plot for the standardized mean difference in sleep duration in children and adolescents during COVID-19 pandemic

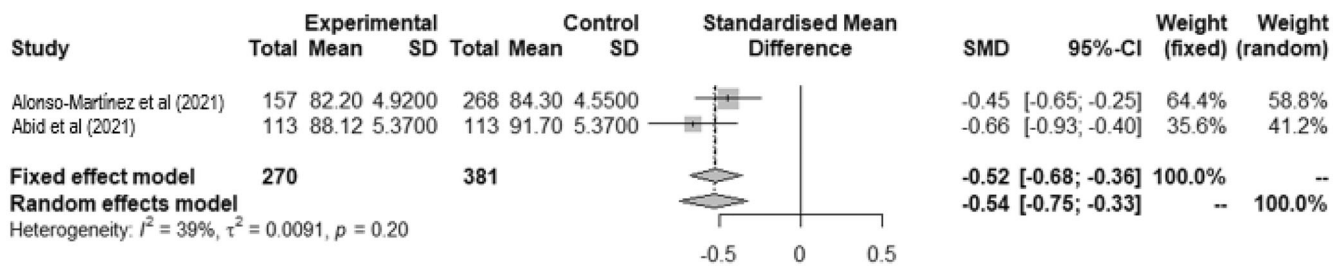


FIGURE 3 Forest plot for the standardized mean difference in sleep efficiency in children and during COVID-19 pandemic

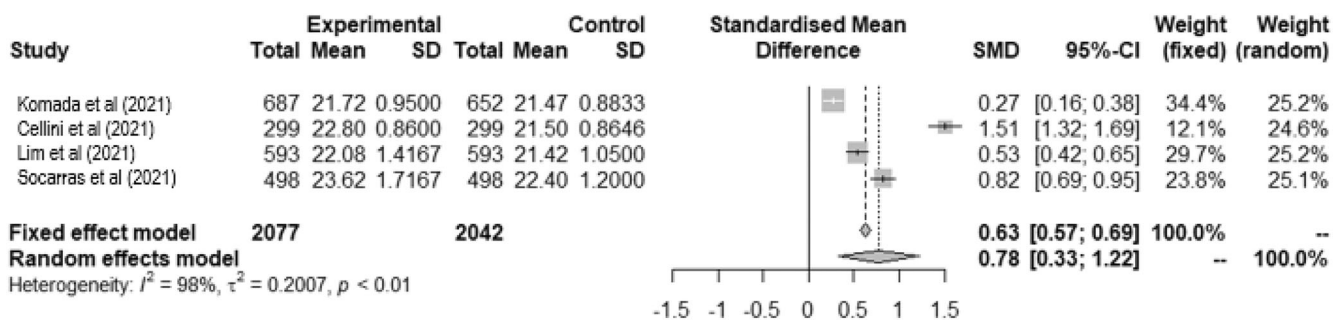


FIGURE 4 Forest plot for the standardized mean difference in bedtime in children and adolescents during COVID-19 pandemic

later have been investigated by some studies showing that they are related to increased eating and decreased physical activity during COVID-19 confinement (Santos & Louzada., Santos & Louzada, 2022; Araby et al., 2021).

Adolescents had a similar scenario to children. The lack of pressure to wake up early to go to school in the morning may explain the improved sleep duration. Sleep duration increased by more than 2 h during the pandemic. Sleepiness during remote classes was reduced versus that reported during traditional classes in 2019. Napping decreased during the pandemic versus 2020 (Santos & Louzada., Santos & Louzada, 2022).

Decreased school motivation was associated with worse sleep quality in adolescents during the pandemic. School demotivation may be linked to the abrupt shift from the traditional to the online model. Furthermore, prospective post-pandemic studies suggest that

reopening schools may exacerbate sleep-related problems among high school students, but may also be beneficial for academic development and physical activity (Puteikis et al., 2022; Silva et al., 2022).

Two meta-analysis studies showed that there was no low sleep efficiency during the confinement (Abid et al., 2021; Alonso-Martinez et al., Alonso-Martinez et al., 2021). In agreement with this finding, a study conducted in the United States with a small sample of children ($n = 16$) but using actigraphy showed that sleep efficiency did not change between periods before or during the COVID-19 pandemic (Lokhandwala et al., 2019).

Sharma et al., published a recent literature review and showed that the prevalence of sleep disturbances in children was 54% and of poor sleep quality was 27% during the first wave of COVID-19 (Sharma et al., 2021). Our present study confirms that sleep duration and sleeping later during COVID-19 confinement were variables that

correlated to poor sleep quality. Unlike the first review, our study adds that the use of electronics as well as the sleep pattern of parents worsened the sleep quality of children and adolescents during the COVID-19 lockdown.

There was a considerable increase in the use of electronics during the pandemic, and this finding was possibly related to decreased sleep quality (Chakraborty et al., 2021; Guo et al., 2021). Screen time can stimulate the brain in ways that make it difficult to relax, and blue light from screens can suppress natural melatonin production, which impairs sleep (National Sleep Foundation, 2022). The results also suggest a lack of parental control during the pandemic because electronics became a constant companion of children and adolescents especially as tools to pass idle time. This was because there were no face-to-face classes, and thus isolation was imposed during the lockdown of the COVID-19 pandemic (Datta et al., Datta & Kundu, 2021).

The studies included here analysed the quality of sleep of parents during the pandemic, which was shown to be impaired. One study evaluated the factors associated with impaired sleep among parents and showed that it could impact the routine of children and adolescents and could reflect anxiety and apprehension about the future (Suffren et al., 2021). Another study looked at changes in family sleep habits, with parents being health professionals who often have elevated fears and concerns regarding COVID-19 (Lokhandwala et al., 2019). This highlights that in addition to the abrupt change in routine, the parents' profession at the time of the pandemic may also influence children's sleep habits.

Limitations include the fact that most of the studies included in the review were observational and cross-sectional. In addition, the metrics used to assess sleep quality were varied (several sleep scales or even a questionnaire developed by the authors), thus making the studies quite heterogeneous. Some studies had no comparison group (e.g., before the pandemic and during the pandemic), which made it difficult to analyse the data in the meta-analysis. Some studies did not investigate bedtime relative to the sleep duration variable, which may interfere with the findings. The literature reviewed was predominantly from online research, which suggests a questionable quality of the inferences drawn from these online studies. Therefore, future studies with different designs besides cross sectional observations are recommended.

5 | CONCLUSION

The results obtained in this systematic review point to changes in sleep characteristics during the pandemic such as increased sleep duration, late bedtimes, and poor sleep quality. These are clearly related to changes in family routines during the pandemic. We emphasise the importance of parents or caregivers encouraging sleep hygiene recommendations to ensure good sleep quality.

AUTHOR CONTRIBUTIONS

The authors Samanta Andresa Richter, Clarissa Ferraz-Rodrigues, Luísa Basso Schilling, and Nathália Fritsch Camargo were responsible

for the preparation of the manuscript, collection, analysis, data interpretation, and writing. The author Magda Lahorgue Nunes was responsible for the analysis, data interpretation, and final writing.

CONFLICT OF INTEREST

This study has no conflicts of interest.

DATA AVAILABILITY STATEMENT

The data that supports the findings of this study are available in the supplementary material of this article.

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