



Sleep Problems Before and During the COVID-19 Pandemic in Children with Autism Spectrum Disorder, Down Syndrome, and Typical Development

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Abstract

Sleep problems are common in children and adolescents, particularly those with Neurodevelopmental Disorders. With the changes in daily habits resulting from the COVID-19 pandemic, we have analyzed sleep characteristics, during social isolation, in Brazilian children and adolescents aged between 4 and 12 years with Autism Spectrum Disorder (N = 267), Down Syndrome (N = 74), and typical development (N = 312). The ASD group presented with worse indicators of sleep habits in the Children's Sleep Habits Questionnaire (CSHQ-BR) and fell asleep later during the pandemic. The entire group started fall asleep and waking up later during the pandemic - as well as waking up more often during the night. These results may contribute to parental guidance and sleep habit-related interventions during and after the COVID-19 pandemic.

Keywords Sleep · COVID-19 · Autistic Disorder · Down Syndrome

The COVID-19 pandemic has impacted upon the daily lives of children and adolescents, with negative effects on sleep habits. These are attributable to several aspects: stress, anxiety, prolonged social isolation, changes in routine, less exposure to sunlight, increased screen time, the disease itself or hospitalization, decreased physical activity and sedentary lifestyle, changes in eating patterns, among others. Each of these factors is individually associated with sleep disturbances under typical circumstances. When these changes are associated with a chronic stressor such as the pandemic, they can contribute to significant further changes

in sleep patterns and behaviors (Becker et al., 2021; Becker & Gregory, 2020). One of the changes found, for instance, was a change in bedtime and risetime (Becker et al., 2021).

A recent meta-analysis showed that the prevalence of sleep disorders in children during the pandemic was 54% (Sharma et al., 2021). A study with Chilean preschool-age children found that during the early stages of the pandemic the time spent engaging in physical activities decreased, whereas both the use of recreational screens and sleep duration increased, thus leading to worsened sleep quality (Aguilar-Farias et al., 2020). On the other hand, when comparing pre- and early-pandemic sleep habits, Chinese preschool children showed changes in bedtime and risetime (both of which occurred later during the pandemic) and fewer sleep disturbances as reported by their caregivers. Some behavioral practices, such as the reduced use of electronic devices and a regular diet, as well as parenting practices including a harmonious environment and better communication between parents and children were associated with fewer sleep disturbances during the isolation period (Liu et al., 2021).

With regard to school-age children, a recent study has reported that school closures resulted in longer sleep duration. Start time of school activities, time spent commuting,

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and screen use were perceived by parents as the most important factors affecting children's sleep (Lim et al., 2021). In addition, anxiety, depression, irritability, boredom, inattentiveness, and fear of contracting COVID-19 were also prevalent factors in children during the pandemic (Panda et al., 2021) that could also be associated with changes in sleep quality. However, adolescents reported less daytime sleepiness and longer sleep duration (Becker et al., 2021).

Considering that sleep disturbances are amongst the most common complaints of parents about children and adolescents with Neurodevelopmental Disorders (Panda et al., 2021) and affect the quality of life of both children and parents (Hvolby et al., 2021), studies have also addressed this population during the pandemic. As reported by parents, 76.9% of children with neurodevelopmental disorders sustained impairments to their health and well-being. Children watched more television and digital media (81.6%), engaged in fewer physical activities (68%), slept less (43.6%) and had a worse diet (32.4%). Nearly 1/5 of families (18.8%) reported increased dosage of medication given to their children (Masi et al., 2021).

In individuals with Autism Spectrum Disorder (ASD), sleep disorders are frequent, with a prevalence rate of around 80% (Damiani et al., 2014; Moore et al., 2017). These can exacerbate core symptoms, such as a decrease in social communication skills, an increase in restricted and repetitive behaviors, and worsened aggressiveness, irritability, and hyperactivity. A study carried out in Slovakia comparing children with typical development and children with ASD showed a delay in bedtime in all children during the first wave of covid-19, with the change being still more significant in children with ASD. During the second wave, there was partial stabilization of sleep routines, in line with pre-covid patterns. Maladaptive behavior in children with ASD increased significantly between waves. In children with ASD, later bedtime was positively correlated with internalizing and externalizing maladaptive behavior, and parental stress (Polonyiová et al., 2021).

A recent study carried out with children and adolescents with ASD showed that the lockdown significantly changed bedtime in 57.8% of participants (56.9% later bedtime; 0.9% earlier bedtime) and risetime in 69.2% of them (61.7% later risetime and 7.5% earlier risetime). Sleep duration increased by 24.1% and decreased by 25%. During confinement, there was a significant increase in sleep disturbances as compared to the previous period, especially those related to falling asleep, anxiety at bedtime, sleep terrors, and daytime sleepiness (Bruni et al., 2022). A study conducted with parents of Italian children and adolescents also compared sleep patterns before and during the COVID-19 lockdown. Children with ASD, ADHD, and a control group participated. The results showed that before confinement, bedtime

and risetime were not different across the groups. During confinement, though, children with ADHD tended to sleep and wake up later, whereas children with ASD maintained similar schedules. Anxiety at bedtime, difficulty falling asleep, and daytime sleepiness increased in all three groups during lockdown. Night awakenings, restless sleep, and daytime sleepiness were particularly increased in patients with ASD and ADHD (Bruni et al., 2021). A study conducted in Turkey also identified a significantly higher number of sleep problems and chronotype scores during the confinement period in children with ASD. (Turkoglu et al., 2020).

Sleep problems also occur in children with Down Syndrome (DS), mainly due to obstructive sleep apnea, the prevalence of which is around 75% (Lee et al., 2018; Yau et al., 2019). It is also worth noting that the cardiovascular anomalies present in DS have a negative impact on sleep-disordered breathing (Horne et al., 2021), with COVID-19 being a risk factor for the worsening of these respiratory conditions (Kantar et al., 2020; Krishnan et al., 2020).

Most of the studies carried out to date include populations from Europe, Asia, and the United States, with scarce data regarding the sleep of children and adolescents with ASD in South American countries, such as Brazil. In view of the impact of sleep disorders both on individual and family life, as well as health problems that may stem therefrom, especially among more vulnerable populations, this study aimed to assess sleep habits as reported by parents and/or guardians during the COVID-19 pandemic of Brazilian children and adolescents with ASD, Down Syndrome, and a control group; it also aimed to describe changes in their sleep routine and hygiene.

Methods

Participants

Initially, 1,287 parents/guardians participated in the study, as selected for convenience. A total of 634 individuals were excluded due to having failed to respond the questionnaire either fully or correctly. Other reasons were lack of important information concerning the characterization of the sample, incomplete information on the participants' sleep habits, and children diagnosed with ASD as a comorbidity with DS. The final sample thus was comprised of 653 children and adolescents of both sexes aged between 4 and 12 years — of whom, 267 (40.88%) had ASD, 74 (11.33%) had DS, and 312 (47.7%) showed typical development (TD). Table 1 shows the sample's characteristics according to each group.

Table 1 Sample's characteristics

Variables	Mean (SD)			F (p)
	ASD	DS	TD	
Child's age	7.30 (2.43)	7.68 (2.39)	7.50 (2.41)	0.91 (0.400)
Caregiver's age	37.69 (7.26)	41.80 (6.54)	39.65 (6.36)	12.69 (0.00)^b
No. of children in the household	1.61 (0.95)	1.66 (0.79)	1.63 (0.81)	0.08 (0.915)
No. of days in isolation	80.50 (21.31)	86.65 (14.47)	85.69 (17.17)	5.29 (0.005)^b
Screen time per day (in hours)	5.43 (3.45)	4.28 (2.47)	5.39 (2.51)	4.55 (0.011)^a
	Frequency n (%)			χ^2(p)
Health care professional at home	58 (21.7%)	21 (28.4%)	112 (35.9%)	65.79 (<0.001)
No. of COVID cases in the household	18 (6.7%)	3 (4.1%)	15 (4.8%)	10.5 (0.005)
Would wake up in the middle of the night before the pandemic	60 (22.5%)	26 (35.1%)	47 (15.1%)	13.28 (0.001)
Wakes up in the middle of the night during the pandemic	131 (49.1%)	37 (50%)	105 (33.7%)	51.78 (<0.001)
Is in isolation	219 (82%)	60 (81.1%)	245 (78.5%)	114.85(<0.001)
Distance Learning Mode	167 (62.5%)	49 (66.2%)	273 (87.5%)	154.06(<0.001)
Participates in synchronous class	99 (37.1%)	36 (48.6%)	211 (67.6%)	136.23(<0.001)
Engages in physical activity	102 (38.2%)	36 (48.6%)	129 (41.3%)	51.438(<0.001)
Uses continuous medication	151 (56.6%)	35 (47.3%)	24 (7.7%)	141.45(<0.001)

Caption: (a) ASD > DS/TD; (b) DS > ASD/TD with a statistically significant difference at $p < 0.05$

Materials

CSHQ-BR: In this study, the translated version of the questionnaire was used, with evidence of validity and accuracy for Brazilian Portuguese (Gios et al., 2020). This questionnaire includes items related to key domains covering the main clinical sleep complaints in the pediatric age group. Its 33 items are conceptually grouped into 8 subscales, reflecting the following sleep domains: bedtime resistance, sleep onset delay, sleep duration, sleep anxiety, night wakings, parasomnias, sleep-disordered breathing, and daytime sleepiness. It is used to screen for sleep disorders in children aged between 4 and 10 years. In this study, we extended the age group to 12 years of age. The frequency of sleep behaviors is rated on a three-point scale, such as “usually” (occurring five to seven times a week), “sometimes” (occurring two to four times a week), or “rarely” (zero times to

once a week) (Owens et al., 2000). Although some studies mention structures consisting of 4 or 5 factors (Johnson et al., 2016; Katz et al., 2018), we have opted to present the results by using the original subscale structure due to the ease in comparing our results with those obtained in previous studies (MacDuffie et al., 2020). In this study, the CSHQ Alpha Coefficient was appropriate not only for the full sample (0.81), but for the ASD (0.83), DS (0.81), and TD (0.79) groups as well.

Identification sheet: questionnaire comprising sociodemographics and general health status information, such as: child's gender and age, caregiver's age, parents' education level, bedtime and risetime, clinical comorbidities and continuous use of medications reported. This initial form also includes questions about the COVID-19 pandemic: whether the child has been in isolation, the number of days spent in isolation, screen time, whether there are other children in the household, whether there is a health care professional in the household, whether there are confirmed COVID cases in the household, whether the child participates in distance learning during the pandemic, and whether the child engages in physical activity.

Procedures

Due to widely disseminated isolation and social distancing standards by the world health authorities at the time, the collection of information was carried out by means of an electronic platform. The research was disseminated on social media, inviting people to voluntarily participate in the survey. Before starting the questionnaire, the caregivers had access to the Voluntary Informed Consent Form and were asked to indicate whether they agreed to participate in the research. The resulting data bank was stored in RedCap, which granted secrecy and confidentiality to participants' data. Data collection was carried out between June and July 2020.

The inclusion criteria for caregivers (parents and/or guardians) were that they needed to be staying with the child for at least 6 nights a week and their consent to taking part in the research. Questionnaires with more than 20% of the questions unanswered were excluded from the study.

Data Analysis

The data were analyzed using the Statistical Package for Social Sciences (SPSS) software – version 21.0. Descriptive analyses based on frequency, mean, and standard deviation were used. In the categorical variables, chi-squared tests were performed in order to check the association across the group being investigated and the other variables. For the continuous scores, the means between the groups were

Table 2 Comparison across groups as to their CSHQ-BR scores

CSHQ	Mean (SD)		TD	F	d _{Cohen}
	ASD	DS			
Bedtime resistance	12.59 (3.33)	11.79 (3.26)	11.58 (3.30)	6.93 ^b	0.31 ^b
Sleep onset delay	1.94 (0.80)	1.59 (0.73)	1.80 (0.81)	6.11 ^a	0.45 ^a
Sleep duration	4.56 (1.67)	4.09 (1.38)	4.18 (1.50)	5.19 ^b	0.24 ^b
Anxiety at bedtime	8.26 (2.19)	7.35 (2.21)	7.71 (2.31)	6.67 ^{ab}	0.41 ^a /0.24 ^b
Night awakenings	5.00 (1.87)	4.85 (1.67)	4.40 (1.73)	8.04 ^b	0.33 ^b
Parasomnias	10.46 (2.61)	10.08 (2.41)	9.73 (2.26)	6.56 ^b	0.30 ^b
Sleep-disordered breathing	4.37 (1.61)	4.41 (1.53)	3.70 (1.07)	20.40 ^c	0.03/0.61 ^c
Daytime sleepiness	11.86 (2.95)	11.27 (2.35)	12.68 (3.27)	8.86 ^d	0.26/0.45 ^d
Total CSHQ	54.37 (9.71)	51.15 (8.77)	51.41 (8.48)	8.57 ^{ab}	0.34 ^a /0.31 ^b

Caption: (a) ASD > DS; (b) ASD > TD; (c) DS > ASD/TD; (d) TD > ASD/DS with a significance level $p < 0.01$ as obtained in Tukey's *post hoc* analysis

compared by using ANOVA and then Tukey's *post-hoc* test and Pearson's bivariate correlation test. Comparison of bedtime, risetime, and night awakenings time before and during the COVID pandemic was carried out by using a paired *t*-test. To compare means across groups while controlling for the effect of variables, the ANCOVA was used. The assumed significance level was $p \leq 0.05$. Effect size was calculated (Lenhard & Lenhard, 2016) when there was a statistically significant difference across the groups.

Results

In regard to the characterization of the sample, 44.7% of caregivers were taking/had taken graduate studies and 30.9% have completed higher education. There was no statistically significant age difference in the children across the three groups. A significant difference was found with respect to the caregiver's age and the number of days spent in isolation during the COVID-19 pandemic, with a higher mean in the group of children with Down Syndrome in comparison to children with ASD and TD. There was also found a difference in relation to screen use, with the longest exposure time in the group of children with ASD when compared to the other groups.

There was a statistically significant association between group and: the presence of health care professionals at home, distance learning mode, and participating in synchronous classes, with a higher percentage of children in the

TD group; confirmed cases of COVID-19 in the household, being in isolation, and using continuous medication, with a higher percentage of cases in the ASD group; and waking up in the middle of the night before and during the pandemic, more often found in children with DS (Table 1).

Comparing the Groups' CSHQ Scores During the Pandemic

When comparing children with ASD, DS, and TD as to their CSHQ scores, there were observed statistically significant differences across the groups not only for all subscales, but also for the total score (Table 2). In general, higher means were observed in the ASD group when compared to the others (in 7 out of the 9 CSHQ-BR scores). The exceptions were the Sleep-disordered breathing subscale, with higher scores in the DS group in relation to the other groups, and the Daytime sleepiness subscale, with a higher mean in the TD group. Therefore, the ASD group had more sleep problems when compared to the other groups.

According to the data presented in Table 2, peer comparison by Tukey's *post hoc* analyses showed that children with ASD present statistically significant differences, with higher scores (indicative of a greater number of sleep problems) in comparison to children with DS and typical development (TD) in the Sleep Anxiety indexes and in the total CSHQ score. Such differences had a small effect size. Specifically in relation to children with DS, the ASD group had more difficulties falling asleep (with a small effect size). And with respect to the TD group, children with ASD had higher scores (indicative of a greater number of sleep problems) in the following indexes: Bedtime resistance, Sleep Duration, Night Awakenings, and Parasomnias. All differences had a small effect size.

Comparing Sleep Characteristics Before and During the Pandemic

Some sleep-related characteristics were evaluated considering the parents'/guardians' report on their child's behavior before and during the COVID 19 pandemic: bedtime, risetime, and number of night awakenings. Table 3 exhibits data collected from the full sample comparing such aspects before and during the pandemic.

There was a statistically significant difference in all measurements, as can be seen in the data presented in Table 3. Children, in general, started going to bed and waking up later during the COVID-19 pandemic, with the difference in bedtime having a large effect size. Differences regarding the children's risetime and number of night awakenings before and during the pandemic had a moderate effect size. Positive, significant correlations of moderate magnitude

Table 3 Sleep-related behaviors before and during the COVID-19 pandemic in the full sample

Variables	Mean (SD)	t test	r	D
Bedtime before COVID	9:24pm (1:06)	-29.79*	0.58*	1.07
Bedtime during COVID	10:56pm (1:36)			
Risetime before COVID	7:15am (1:29)	-19.32*	0.45*	0.79
Risetime during COVID	8:37am (1:53)			
Number of night awakenings before COVID	1.48 (0.79)	-6.22*	0.50*	0.52
Number of night awakenings during COVID	2.02 (1.14)			

Caption: significant difference or correlation with a * $p \leq 0.001$

were also observed between measurements before and during the pandemic (Table 3), as was an association between participating in synchronous online classes and bedtime ($\chi^2 = 817.77$; $p < 0.001$) and risetime ($\chi^2 = 14.16$; $p < 0.001$) during the pandemic.

Intra-group Comparisons and Correlations in Sleep Characteristics Before and During the Pandemic

Figure 1 displays sleep data relative to bedtime, risetime, and number of night awakenings before and during the pandemic according to group.

ASD

In children with ASD, bedtime before the pandemic was positively and significantly correlated with bedtime ($r = 0.58$; $p < 0.001$) and risetime ($r = 0.48$; $p < 0.001$) during the pandemic with moderate magnitude. Risetime before the pandemic was significantly correlated with risetime ($r = 0.42$; $p < 0.001$) and bedtime ($r = 0.35$; $p \leq 0.001$) during the pandemic. The number of night awakenings before and during the pandemic was also correlated ($r = 0.64$; $p \leq 0.001$).

During the pandemic, risetime was correlated with bedtime ($r = 0.72$; $p \leq 0.001$) and the latter with the participants' number night awakenings ($r = 0.20$; $p = 0.019$). Although

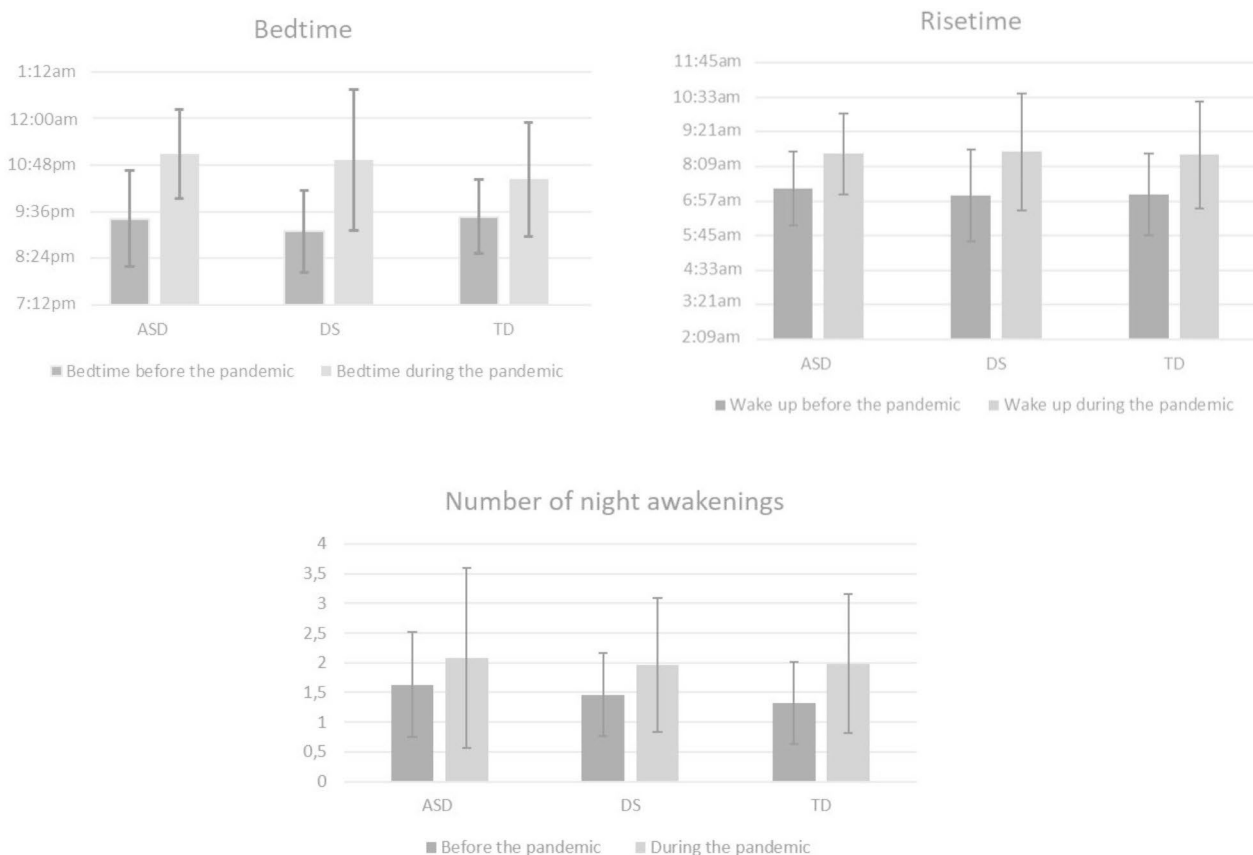


Fig. 1 Bedtime, Risetime, and Number of night awakenings
 Legend: ASD - Autism Spectrum Disorder; DS - Down Syndrome; TD - typical development

correlated, there was a significant difference between before and during the pandemic for: bedtime ($t_{(266)}=-18.043$; $p<0.001$; $d_{\text{Cohen}}=1.01$); risetime ($t_{(266)}=-9.934$; $p<0.001$; $d_{\text{Cohen}}=0.65$); and number of night awakenings ($t_{(48)}=-3.99$; $p\leq 0.001$; $d_{\text{Cohen}}=0.48$).

Down Syndrome

In the group of children with DS, bedtime before the pandemic was positively and significantly correlated with bedtime ($r=0.67$; $p<0.001$) and risetime ($r=0.52$; $p<0.001$) during the pandemic with moderate magnitude. Likewise, participants' risetime before the pandemic was correlated with risetime ($r=0.60$; $p<0.001$) and bedtime ($r=0.39$; $p=0.001$) during the pandemic. Finally, the children's number night awakenings before and during the pandemic was also positively and significantly correlated ($r=0.49$; $p=0.014$). Although correlated, there was a significant difference between before and during the pandemic for: bedtime ($t_{(73)}=-12.725$; $p<0.001$; $d_{\text{Cohen}}=1.20$); risetime ($t_{(73)}=-9.705$; $p<0.001$; $d_{\text{Cohen}}=1.00$); and number night awakenings ($t_{(25)}=-2.388$; $p=0.025$; $d_{\text{Cohen}}=0.47$); On average, children's bedtime occurred one hour later during the pandemic.

Typical Development

In the TD group, correlations were also positive, significant and of moderate magnitude between measurements before and during the pandemic: bedtime ($r=0.58$; $p<0.001$); risetime ($r=0.45$; $p<0.001$); and the number night awakenings ($r=0.62$; $p\leq 0.001$). Children's bedtime before the pandemic was also correlated with their risetime before ($r=0.36$; $p<0.001$) and during ($r=0.35$; $p=0.001$) the pandemic, but with low magnitude. However, there were significant differences between before and during the pandemic in terms of bedtime ($t_{(311)}=-21.438$; $p<0.001$; $d_{\text{Cohen}}=1.11$); risetime ($t_{(311)}=-15.108$; $p<0.001$; $d_{\text{Cohen}}=0.89$); and the number of night awakenings ($t_{(40)}=-4.250$; $p=0.025$; $d_{\text{Cohen}}=0.58$).

Comparing the Groups as to Their Sleep Characteristics Before and During the Pandemic

With respect to sleep characteristics before the pandemic, there was a statistically significant difference across the groups regarding bedtime ($F_{(2,650)}=3.28$; $p=0.038$), specifically between the DS group ($M=9:06\text{pm}$; $SD=1:03$) and the TD group ($M=9:28\text{pm}$; $SD=0:57$), with a small effect size ($p=0.029$; $d_{\text{Cohen}}=0.32$). There was no difference between the ASD group ($M=9:25\text{pm}$; $SD=1:14$) and the other groups. There were no statistically significant differences either across the groups with regard to risetime

($F_{(2,650)}=1.65$; $p=0.193$) or the number night awakenings ($F_{(2,650)}=2.12$; $p=0.125$) before the pandemic started.

Considering the difference across the groups with regard to bedtime before the COVID-19 pandemic, a covariance analysis was conducted to compare groups with respect to bedtime during the pandemic while controlling for the effect of bedtime before the pandemic. The ANCOVA results showed that after controlling for the effect of bedtime before the pandemic, when comparing the groups for bedtime during the pandemic, there was a marginal effect, i.e. it was almost significant across the groups ($F_{(2,649)}=2.97$; $p=0.052$). Specifically, there was a significant difference ($p=0.029$) between the ASD group ($M=11:05\text{pm}$; $SD=1:49$) and the DS group ($M=10:26\text{pm}$; $SD=1:09$); and a trend ($p=0.081$) between the ASD and TD groups ($M=10:56\text{pm}$; $SD=1:28$), as compared in pairs by LSD analysis (*post hoc*), indicating that children with ASD tended to sleep later during the pandemic.

In addition to the significant difference between the DS and TD groups with regard to bedtime before the pandemic, there was a positive, significant relationship with moderate magnitude between bedtime before and during the pandemic (Table 3), as well as between bedtime before the pandemic and risetime before ($r=0.43$; $p<0.001$) and during the pandemic ($r=0.42$; $p<0.001$) in the general group. Therefore, we used bedtime and risetime before the pandemic as covariates for comparison across groups in relation to risetime during the pandemic. The ANCOVA results showed that after controlling for the mentioned variables, there was no statistically significant difference across the groups with regard to risetime during the pandemic ($F_{(2,648)}=0.720$; $p=0.487$).

By comparing the groups as to the number of night awakenings during the pandemic, we controlled for the effect of the number night awakenings before the pandemic due to a positive, significant, and moderate magnitude correlation between both variables. ANCOVA results indicated that there was no significant difference across the groups ($F_{(2,111)}=0.126$; $p=0.882$).

Relationship Between CSHQ Score and environmental/sociodemographic Variables

By analyzing the relationship between the total CSHQ score in the full sample and the variables described in Table 1, a statistically significant association was found between sleep problems and: the presence of health care professionals at home ($\chi^2=91.57$; $p<0.001$); engaging in physical activities ($\chi^2=106.96$; $p<0.001$); and being in isolation ($\chi^2=264.87$; $p<0.001$). The presence of a health professional at home and engaging in physical activities were associated with lower CSHQ scores on the, i.e., fewer sleep problems. There were

also a greater number of children in social isolation with fewer sleep problems. No association was found between worse sleep indexes and the presence of confirmed COVID cases in the household ($\chi^2 = 8.75$; $p = 0.990$).

The correlation between CSHQ total score and caregivers' age was positive, significant, but with low magnitude ($r = 0.12$; $p = 0.003$); the same applies to screen time ($r = 0.09$; $p = 0.025$) and children's age ($r = 0.08$; $p = 0.035$). There was no correlation between CSHQ score and the number of days spent in isolation ($r = -0.01$; $p = 0.687$).

Discussion

The occurrence of the pandemic caused by the new coronavirus affected the routine of children and their families, with an impact on learning, mental health, habits, and forms of interaction in the family environment (Becker & Gregory, 2020; Dellagiulia et al., 2020). Other aspects also affected were routine and quality of sleep of children and adolescents (Becker et al., 2021; Gruber et al., 2020; Liu et al., 2021). In view of the previous literature that reports a greater number of sleep problems in individuals with ASD as compared to those with typical development (Carmassi et al., 2019; Damiani et al., 2014; Moore et al., 2017), this study sought to investigate sleep habits and characteristics in children and adolescents with ASD, DS, and TD as affected by the pandemic.

First, we compared the groups in the CSHQ, a questionnaire that assesses sleep habits as reported by the main caregiver (Owens et al., 2000). Despite differences in relation to the instrument's internal structure (Johnson et al., 2016; Katz et al., 2018), for the analysis we used total score and the eight original domains (Owens et al., 2000) in order to allow for the comparison of the results with those previously published in the literature (MacDuffie et al., 2020).

Prior to the pandemic, studies already mentioned the high prevalence of sleep disorders in the pediatric age group, with estimates around 20–30% in children with TD and 80% in children with ASD (Damiani et al., 2014; Moore et al., 2017). The results obtained in this study showed that, in general, children with ASD have a greater number of sleep impairments as compared to the other groups across most evaluated domains, as well as in the total CSHQ-BR score. Children with ASD have greater bedtime resistance, falling asleep, sleep duration and anxiety at bedtime, night awakenings, and parasomnias. Previous studies have reported that children with ASD often present with sleep onset delay, night awakenings, and early risetime. Bedtime resistance can be associated with a variety of factors such as anxiety, sleep onset-related problems, hyperactivity, and general dysregulation (Moore et al., 2017; Souders et al., 2017).

Thus, the sleep habits found in our study, with worse overall indexes in the group of children with ASD, corroborate data previously published in the literature (Polonyiová et al., 2021; Turkoglu et al., 2020), reflecting difficulties that possibly already existed before the pandemic and that may have worsened due to several circumstantial factors such as: changes in routine, fear and anxiety, external stressors, use of electronic devices, difficulty in maintaining therapies, and access to medications during confinement.

The DS group showed a great number of sleep alterations only in the domain of respiratory disorders, which was a previously expected result (Dumortier & Bricout, 2020; Kantar et al., 2020; Krishnan et al., 2020). Individuals with DS have some clinical characteristics, such as metabolic, endocrine, anatomical, and neurological disorders that contribute to the pathophysiology of obstructive sleep apnea, which causes the prevalence of this disorder to be high in this population, with critical consequences in terms of quality of health and life, such as cardiovascular risk and obesity (Dumortier & Bricout, 2020).

The TD group was the one with the greater number of daytime sleepiness-related impairments. According to the literature, excessive daytime sleepiness is common in school children, with an estimated prevalence of around 15% as reported by parents or teachers. Sleepiness has significant adverse effects on learning, mood, and quality of life. Among its known causes, there is insufficient sleep associated with poor sleep hygiene, medical issues, and medication use (Marcus, 2018).

When considering the CSHQ-BR means (and variations thereof), it is also noteworthy that the three groups had scores compatible with sleep impairments, considering 41 as the cutoff point score established in previous studies with other populations (Owens et al., 2000; Liu et al., 2020). This result may be due to changes in development, family environment, and routine over the years, since the CSHQ cut-off point was established over 20 years ago. Such changes may have led to an increase in CSHQ scores. A Brazilian study carried out prior to the COVID-19 pandemic found a mean of 46.85 (± 9.43) for the total CSHQ score in children with TD, a finding that was already suggestive underlying problems with respect to sleep habits in this population (Gios et al., 2020) which intensified during the pandemic.

In the full sample of this study, it was found that, during the pandemic, individuals began to sleep and wake up later, the same data as also obtained by other authors (Bruni et al., 2021, 2022; Liu et al., 2020; Gruber et al., 2020). An increase in the number of night awakenings was also seen. However, total sleep time before and during the pandemic remained unchanged around 9 h. According to the National Sleep Foundation, the recommended number of hours of sleep for preschoolers range from 10 to 13 h, whereas for

school children it ranges between 9 and 11 h (Hirshkowitz et al., 2015). This shows that, on average, participants in this study slept the minimum number of hours considered appropriate for school-age children, both before and during the pandemic. Nevertheless, findings on sleep during the pandemic are heterogeneous (Becker et al., 2021; Sharma et al., 2021). A study with preschool children suggested that the pandemic's initial phase was a critical period for children's sleep in terms of routine organization and sleep quality, with a decrease in the amount of sleep time and subsequent stabilization (Dellagiulia et al., 2020). Zreik et al. (2021), in turn, did not observe changes in sleep quality during the pandemic in children aged between 6 and 72 months, as reported by their mothers (Zreik et al., 2021).

Several factors associated with the COVID-19 pandemic can interfere with the sleep pattern of children and adolescents. Confinement, changes in routine, high levels of anxiety, decreased exposure to sunlight, increased screen time and digital social media usage, changes in diet, and reduced physical activity can negatively impact upon sleep quality during the pandemic (Aguilar-Farias et al., 2020; Becker et al., 2021; Becker & Gregory, 2020; Masi et al., 2021; Zreik et al., 2021). In line with these findings, we found that children and adolescents who engaged in physical activities during the pandemic had fewer sleep problems according to their scores on the CSHQ-BR. On the other hand, the correlation with screen time was of very low magnitude, i.e., practically absent.

While children and adolescents may experience worsened sleep habits during the COVID 19 pandemic, it is also possible that some may experience improvement in certain domains. Among the possible causes for the improvement are: greater flexibility in working hours; more sleep time in view of less time spent in traffic, with social and extracurricular activities; the possibility of organizing a schedule aligned with one's endogenous circadian rhythm (with greater consistency between sleep during the week and weekends); reduction of social and academic stressors, therefore reduced rumination and anxiety at bedtime; and the possibility of strengthening family ties, as well as shared activities that promote a sense of connection and safety (Becker & Gregory, 2020; Lim et al., 2021). The closing of schools during the pandemic, the flexibility of some schools for the start time of remote activities, and the use of internet were mentioned by parents as the main factors affecting children's sleep (Lim et al., 2021).

Our results also show an association between a decrease in sleep problems as reported by parents in the CSHQ-BR and the presence of health care professionals at home. One hypothesis is that care for the children's daily routine was assigned to other people due to the health care professional's need for isolation. The presence of health professionals

at home can become an anxiogenic factor as the fear of contracting or transmitting the virus intensifies, since such professionals belong to a group that is at greater risk and vulnerability. Emotional symptoms are known to be cardinal in several mood disorders. Relatively common changes, such as difficulty in sleeping alone and increased sleep onset latency, are predictors of depression and severity of anxiety symptoms over time (Whalen et al., 2017).

With regard to the limitations to this study, despite the investigation of COVID cases in the household, no question was asked as to whether or not the child had had this diagnosis, which could be an additional interfering factor for sleep patterns. Data concerning sleep characteristics before the pandemic were collected only during the pandemic as reported by parents/guardians. Diagnoses of "ASD" and "DS" were as reported by caregivers.

According to information from the Brazilian Institute of Geography and Statistics (*Instituto Brasileiro de Geografia e Estatística*, the acronym of which is *IBGE*), around 51% of the adult population have at most completed elementary school and only 15.3% of this population have completed higher education (IBGE, 2016). One bias in this study was that most of the participating caregivers had completed higher education and graduate degrees, which may not be fully representative of the Brazilian population, given its heterogeneity from a cultural and socioeconomic perspective.

Finally, the results obtained with this study indicate that during the period of isolation due to the COVID-19 pandemic, a sample of Brazilian children and adolescents with TD, DS, and ASD experienced sleep problems, with worse indexes having been observed in the ASD group. For this reason, this should be one of the aspects to be considered by health care teams when assessing and monitoring such individuals.

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Declarations

Competing Interests The authors have no competing interests to declare.

Ethics Approval The study was approved by the Institutional Ethics Committees (Protocol number: 4.066.673; CAAE: 99698918.1.0000.5479) of Irmandade Santa Casa de Misericórdia de São Paulo and was performed in accordance with the principles of the Declaration of Helsinki.

Consent to Participate Informed consent was obtained from caregivers.

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agencies. Authors have accepted responsibility for the entire content of this manuscript and approved submission. The study was approved by the Ethics Committee.

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