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ORIGINAL ARTICLE

# Sleep disturbances in children with cystic fibrosis, primary ciliary dyskinesia and typically developing children during COVID-19 pandemic

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**Aim:** We aimed to investigate sleep disturbances in children with cystic fibrosis (CF) and primary ciliary dyskinesia (PCD) and typically developing (TD) children during the COVID-19 pandemic.

**Methods:** Primary care givers of children with CF and PCD aged 3–16 years were asked to enrol in the study. Primary care givers of TD children were included as control group. The Sleep Disturbance Scale for Children (SDSC) was used, and questions related to sleep habits during the pandemic were asked. Results of the three groups were compared.

**Results:** Primary care givers of 33 children with CF, 16 children with PCD and 66 TD children were included in the study. There were no differences in terms of age and gender between the three groups. Changes in sleep patterns during the pandemic were more common among TD children and their families, with 75% of the children and 80% of their families sleeping later than before. The sleep initiation and maintenance disorder scores were higher in TD children ($P = 0.001$), whereas the sleep breathing disorder scores were higher in children with PCD ($P = 0.001$), and the sleep hyperhidrosis scores were higher in children with CF and PCD ($P = 0.011$). No relationships were found between sleep parameters and clinical findings of children with lung disease.

**Conclusions:** Children's sleep habits have changed during the pandemic. Children with chronic lung diseases and even TD children may experience sleep disturbances during this period.

**Key words:** children; COVID-19; cystic fibrosis; primary ciliary dyskinesia; sleep.

**What is already known on this topic**

1 Lifestyle changes during the pandemic may change children's sleep habits.
2 There are no data on sleep habits and disturbances of children with cystic fibrosis and primary ciliary dyskinesia during the COVID-19 pandemic.

**What this paper adds**

1 Children with chronic lung diseases and even typically developing children may experience sleep disturbances during the pandemic.
2 Changes in sleep patterns of children and their families and also disorders of initiating and maintaining sleep were found more frequently in typically developing children which could be attributed to less awareness of good sleep practices.

The coronavirus disease 2019 (COVID-19) pandemic is a public health emergency of international concern and is psychologically affecting people all over the world. Fear of infection and uncertainty about the disease cause anxiety and mental stress. Moreover, measures taken to contain the disease, such as stay-at-home orders, social distancing and restrictions on outdoor physical activity have led to life-style changes, which can result in sleep difficulties.[1,2]

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Cystic fibrosis (CF) and primary ciliary dyskinesia (PCD) are chronic lung diseases that may be accompanied by sleep disorders. Recurrent sinusitis, nasal polyposis and lower respiratory tract infections in both diseases may cause sleep-disordered breathing.[3,4] In turn, sleep-disordered breathing, as well as medications that interfere with sleep, may cause sleep disturbances. Sleep may also be directly affected by disease-related symptoms, such as cough and pain.[5] It was shown that children with CF, even when they are clinically stable, got less sleep than their peers due to more frequent nightly awakenings. In addition, disease severity was related to sleep disturbance and daytime sleepiness.[6] Low baseline $SpO_2$, $FEV_1 < 80\%$, CF-related diabetes, Percutaneous endoscopic gastrostomy (PEG) feeding and comorbid behaviour disorder were found to be associated with lower sleep quantity in children with CF. Moreover, family characteristics such as paternal smoking and family member with a mood

disorder and poor sleep hygiene were shown to be associated with sleep disturbances.[7] During this pandemic, as all children, children with CF and PCD may be psychologically affected by life-style changes, such as not going to school, home isolation and limited peer relationships. It is also known that anxiety and depression are common in children with CF and PCD.[8–10] As lung involvement is prominent in COVID-19, these children may experience even higher levels of anxiety during this period. These factors combined can lead to sleep disorders in these children.

Sleep is essential for optimal physical and mental health, immune function and cognition. Sleep disorders may interfere with the physical, cognitive, emotional and social development, especially of children.[11] Impaired sleep quality and excessive daytime sleepiness were found to be related to lower mood and health related quality of life in children and adolescents with CF.[12] As this is the most severe pandemic in generations, the effects of this situation on children's sleep and their consequences are unknown. This study aimed to investigate the impact of the COVID-19 pandemic on sleep disturbances in children with CF and PCD and typically developing (TD) children, and compare the three groups.

## Materials and Methods

All primary care givers of children with CF and PCD aged 3–16 years regularly followed up in the Paediatric Pulmonology Department in a university hospital were asked to enrol in the study. Primary care givers of TD children of the same age range were recruited using snowball sampling and served as a control group. Because of the risk of COVID-19, this study conducted interviews via teleconference between 6 July 2020 and 10 July 2020. Curfew restriction for children was started in the beginning of April 2020 and schools were closed in March 2020. Curfew restrictions were applied to people under 20 years both in weekdays and weekend between April to mid-June. The interviews were conducted by the doctors who were regularly following up the children in the paediatric pulmonology department. Care givers who did not wish to participate were excluded.

Data collected for all groups included the children's age, gender, weight and height. Body mass index (BMI) was calculated. Weight and height of children were noted which were measured by their parents at home. The Sleep Disturbance Scale for Children (SDSC) was used to assess sleep disturbances. Questions about sleep habits during the COVID-19 pandemic were asked.

For the CF and PCD groups, clinical data were obtained from the children's hospital files. The number of hospitalizations in the past year, number of sputum cultures positive for any bacteria in the past year, presence of chronic *Pseudomonas* infection and mean follow-up duration were noted. Chronic *Pseudomonas* infection was defined as *P. aeruginosa* positivity in more than 50% of the samples collected over a period of 12 months.[13] Results of pulmonary function tests (PFTs) were recorded for patients who could perform spirometry in the last follow-up, and forced vital capacity (FVC), forced expiratory volume (FEV), FEV in 1 s (FEV1) and forced expiratory flow at 25–75% of the pulmonary volume (FEF25–75) spirometry tests were recorded as predicted percentages. The FEV1/FVC ratio was recorded and assessed based on age, gender and height.

The SDSC, developed for children aged 6–16 years, evaluates disorders of initiating and maintaining sleep (DIMS), sleep breathing disorders, disorders of arousal (DA), sleep–wake transition disorders (SWTD), disorders of excessive somnolence (DOES) and sleep hyperhidrosis (SHY) during the previous 6 months.[14] The six subscales are scored on a 5-point Likert scale. The sum of scores provides a total score ranging from 26 to 130. Higher scores indicate more severe disturbances.[15] This tool has been translated into many languages with satisfactory results in terms of validity and reliability. A Turkish version was validated by Akcay *et al*., and used in the study.[16] Romeo *et al*. applied the SDSC to pre-school children (3–6 years).[17] In this study, the questionnaire was administered to the primary care givers.

An additional 21 questions were prepared by the authors to investigate changes in children's sleep habits during the COVID-19 pandemic. The questions regarded changes in the sleep patterns of the child or family members, changes in the child's temperament and commitment to mother, daily activity changes, changes in and total duration of screen time, weight changes during the pandemic, daytime sleep, activities with the parents at home that were not related to education, playing with friends, whether the child preferred playing with friends or the parents, whether the child slept late, whether the child slept with the parents, whether the child had nightmares, whether the house had a garden and whether there were smokers at home. These questions were shown in Table 1.

Comparisons between the results of the three groups were performed. For the CF and PCD groups, relationships between sleep-related results and the patients' clinical data were investigated.

Statistical analyses were performed using IBM SPSS Statistics version 22.0 (IBM Corp., Armonk, NY, USA) for Windows. Descriptive statistics were expressed as numbers and percentages for categorical variables and means ± standard deviations and medians and interquartile ranges for continuous variables. The normality of distribution of continuous variables was assessed with visual (histograms and probability graphics) and analytic methods (Kolmogorov-Smirnov and Shapiro-Wilk test). For comparisons between two groups, the Mann-Whitney *U* test was used for data that did not fit the normal distribution, and the independent samples *t*-test was used for data that fit the normal distribution. For comparisons between three groups, one-way analysis of variance (ANOVA) was performed where the parametric test conditions were satisfied, and the Kruskal-Wallis *H* test was performed where the parametric test conditions were not satisfied. For significant ANOVA results, binary comparisons between groups were performed with the Bonferroni multiple comparison test. For significant Kruskal-Wallis *H* test results, binary comparisons between groups were performed with the Dunnett's multiple comparison test. Comparisons of categorical variables between independent groups were performed with the $\chi^2$ test. Relationships between data that did not fit the normal distribution were evaluated with Spearman's correlation test, and relationships between data that fit the normal distribution were evaluated with Pearson's correlation test. A value of $P < 0.05$ was considered statistically significant.

## Results

A total of 33 primary care givers of children with CF, 16 primary care givers of children with PCD and 66 primary care givers of

**Table 1** Results of the questions regarding the children's and their families' sleep and daily habits during the COVID-19 pandemic[†]

| Questions | Children with CF ($n = 33$) *Yes*, *n* (%) | Children with PCD ($n = 16$) *Yes*, *n* (%) | TD children ($n = 66$) *Yes*, *n* (%) | *P* value |
|---|---|---|---|---|
| Have the family's sleep patterns changed during the pandemic? | 17 (51) | 5 (31) | 50 (75) | **0.001**[‡] |
| Have the child's sleep patterns changed during the pandemic? | 17 (51) | 7 (43) | 50 (75) | **0.011**[‡] |
| Has the family been sleeping later during the pandemic? | 18 (54) | 5 (31) | 50 (75) | **0.002**[‡] |
| Has the child been sleeping later during the pandemic? | 21 (63) | 7 (43) | 53 (80) | **0.010**[‡] |
| Did the child sleep with the parents before the pandemic? | 7 (21) | 2 (12.5) | 11 (16) | NA |
| Has the child been sleeping with the parents during the pandemic? | 5 (15) | 2 (12.5) | 20 (30) | NA |
| Has the child's commitment to mother increased during the pandemic? | 13 (39) | 6 (37.5) | 37 (56) | 0.157[‡] |
| Does the child insist on doing everything with the parents? | 6 (18) | 0 (0) | 15 (22) | NA |
| Has the child's temperament been negatively affected during the pandemic? | 8 (24) | 5 (31) | 29 (43) | 0.142[‡] |
| Has the child been demanding and surly during the pandemic? | 10 (30) | 7 (43) | 25 (37) | 0.618[‡] |
| Does the child prefer staying at home during the pandemic? | 14 (42) | 5 (31) | 25 (37) | 0.749[‡] |
| Does the child prefer the parents to friends during the pandemic? | 13 (39) | 5 (31) | 25 (37) | 0.852[‡] |
| Has the child's screen time increased during the pandemic? | 26 (78) | 12 (75) | 59 (89) | 0.212[‡] |
| What is your child's mean daily screen time? | | | | |
| Before COVID-19 (h) | 2 (1–2.75) | 2 (0.62–2) | 2 (1–3.75) | 0.192[§] |
| During COVID-19 (h) | 4 (3–6) | 5.5 (3.25–7.75) | 5 (4–6) | 0.451[§] |
| Has the child's daily sleep duration changed during the pandemic? | 2 (6) | 2 (12.5) | 9 (13.6) | NA |
| Has the child been having nightmares during the pandemic? | 1 (3) | 0 (0) | 6 (9) | NA |
| Has the child been playing in the garden during the pandemic? | 12 (36) | 8 (50) | 29 (43) | 0.628[‡] |
| Has the child been playing with friends during the pandemic? | 4 (12) | 9 (56) | 21 (31) | **0.005**[‡] |
| Have the child's daily activities changed during the pandemic? | 18 (54) | 9 (56) | 36 (54) | 0.992[‡] |
| Have family activities with the child at home not related to education increased during the pandemic? | 23 (69) | 12 (75) | 48 (72) | 0.916[‡] |
| Does anybody smoke at home? | 2 (6) | 6 (37.5) | 11 (16) | NA |
| Has the child's weight changed during the pandemic? | 11 (33) | 12 (75) | 42 (63) | **0.005**[‡] |

[†]Each question is evaluated within itself.

[‡]Chi-square test.

[§]Kruskal-Wallis *H* test.

NA: not applicable (The number of data is small and statistical analysis cannot be made).

CF, cystic fibrosis; PCD, primary ciliary dyskinesia; TD, typically developing.

Bold number indicates statistically significant value.

TD children were included in the study. All primary care givers were their mothers. Comparisons of age, gender and BMI *z*-scores between the children in the three groups are presented in Table 2. The mean age of the children with CF was 9.5 years (7–12 years), the mean age of the children with PCD was 10.5 years (8.1–12.7 years) and the mean age of the TD children was 8 years (5.3–11.2 years). There were no statistically significant differences in terms of age and gender between the three groups.

The clinical data of the patients with CF and PCD are presented in Table 2. The mean follow-up duration was $96.45 \pm 35.6$ months for children with CF and $43.0 \pm 26.7$ months for children with PCD ($P = 0.001$). Seven (21%) children with CF and 6 (37%) children with PCD had been hospitalised in the past year ($P = 0.163$). Twenty-one (63%) children with CF and 3 (23%) children with PCD had tested positive for bacteria ($P = 0.008$). Chronic infections had been detected in 12 children with CF, five of whom were infected with

**Table 2** Comparisons of demographic features and body mass index *z*-scores of the children in the three groups

| | Children with CF ($n = 33$) | Children with PCD ($n = 16$) | TD children ($n = 66$) | *P* value |
|---|---|---|---|---|
| Age (years), median (range) | 9.5 (7–12) | 10.5 (8.1–12.7) | 8 (5.3–11.2) | 0.112[†] |
| Gender, male/female | 19/14 | 8/8 | 34/32 | 0.821[‡] |
| BMI *z*-score, mean ± SD | −0.81 ± 1.03 | 0.03 ± 1.22 | 0.48 ± 1.17 | **0.001**[§,*] |
| Mean follow-up duration, mean ± SD | 96.45 ± 35.6 | 43.0 ± 26.7 | | **0.001**[¶] |
| Number of hospitalised patients in the past year, *n* (%) | 7 (21) | 6 (37) | | 0.163[‡] |
| Number of patients with positive sputum cultures in the past year, *n* (%) | 21 (63) | 3 (18) | | **0.008**[‡] |
| Patients with chronic infections, *n* (%) | 12 (36) | 0 (0) | | |
| FEV1%, mean ± SD | 75.8 ± 25.6 | 93.6 ± 14.6 | | **0.017**[¶] |
| FVC %, mean ± SD | 75 ± 24.6 | 96.6 ± 15.5 | | **0.005**[¶] |
| FEF25–75%, mean ± SD | 73.9 ± 31.7 | 96.2 ± 22.9 | | **0.035**[¶] |
| FEV1/FVC, median (range) | 101 (96.5–104) | 99 (96.5–104) | | 0.701[††] |

[*]Level of significance: Typically developing children > Children with CF.

[†]Kruskal-Wallis *H* test.

[‡]Chi-square test.

[§]One-way analysis of variance (ANOVA).

[¶]Independent samples *t*-test.

[††]Mann-Whitney *U* test.

BMI, body mass index; CF, cystic fibrosis; FEF25–75, forced expiratory flow at 25–75% of the pulmonary volume; FEV1, forced expiratory volume in 1 s; FVC, forced vital capacity; PCD, primary ciliary dyskinesia; SD, standard deviation; TD, typically developing.

Bold number indicates statistically significant value.

**Table 3** Comparisons of the Sleep Disturbance Scale for Children scores between the three groups

| | Children with CF ($n = 33$) | Children with PCD ($n = 16$) | TD children ($n = 66$) | *P* value |
|---|---|---|---|---|
| Disorders of initiating and maintaining sleep, mean ± SD | 11.6 ± 2.9 | 11.9 ± 3.2 | 14.0 ± 4.0 | **0.001**[§,*] |
| Sleep breathing disorders, median (range) | 4 (3–4.5) | 5 (3–7) | 3 (3–4) | **0.001**[¶,†] |
| Disorders of arousal, median (range) | 3 (3–4) | 3 (3–4) | 3 (3–4) | 0.910[¶] |
| Sleep–wake transition disorders, median (range) | 9 (7–11) | 8.5 (6–10) | 8 (6–10) | 0.219[¶] |
| Disorders of excessive somnolence, median (range) | 6 (5–9) | 6 (5–8.7) | 5 (5–7) | 0.347[¶] |
| Sleep hyperhidrosis, median (range) | 3 (2–5) | 3 (2–4) | 2 (2–3) | **0.011**[¶,‡] |
| Total SDSC score, median (range) | 39 (33–47) | 39.5 (35.5–44) | 38 (33–42) | 0.649[¶] |
| *T* score, median (range) | 53 (46–62) | 53.5 (48.5–58.5) | 51 (46–56) | 0.754[¶] |

[*]Level of significance: TD children > Children with CF.

[†]Level of significance: Children with PCD > TD children.

[‡]Level of significance: Children with PCD > TD children. Children with CF > TD children.

[§]One-way analysis of variance (ANOVA).

[¶]Kruskal-Wallis *H* test.

CF, cystic fibrosis; PCD, primary ciliary dyskinesia; SDSC, Sleep Disturbance Scale for Children; TD, typically developing.

Bold number indicates statistically significant value.

*Pseudomonas aeruginosa,* six with *Staphylococcus aureus* and one with *Haemophilus influenzae*. Only nine patients with PCD and 27 patients with CF could perform PFTs. The mean FEV1 was 75.8 ± 25.6 in children with CF and 93.6 ± 14.6 in children with PCD ($P = 0.017$). The mean FVC was 75 ± 24.6 in children with CF and 96.6 ± 15.5 in children with PCD ($P = 0.005$). The FEF25–75 results were significantly lower in children with CF (73.9 ± 31.7) than in children with PCD (96.2 ± 22.9; $P = 0.035$). There was no significant difference in terms of FEV1/FVC results between children with CF (101 [96.5–104]) and children with PCD (99 [96.5–104]; $P = 0.701$).

Comparisons of the SDSC scores between the three groups are shown in Table 3. There were no differences in terms of sleep

duration and time to fall asleep after going to bed between the three groups ($P = 0.659$ and $P = 0.284$, respectively). The DIMS score was higher in TD children ($P = 0.001$), the SDB score was higher in children with PCD ($P = 0.001$) and the SHY score was higher in children with PCD and CF ($P = 0.011$). No statistically significant differences were observed in DA, SWTD and DOES scores between the three groups. Four children with CF, 1 child with PCD and 21 TD children scored in the clinically significant range for the DIMS; 3 children with CF, 6 children with PCD and 1 TD child scored in the clinically significant range for the SDB; 4 children with CF, 2 children with PCD and 11 TD children scored in the clinically significant range for DA; 3 children with CF and 2 TD children scored in the clinically significant range for SWTD; 3 children with CF scored in the clinically significant range for DOES; 4 children with CF, 3 children with PCD and 6 TD children scored in the clinically significant range for SHY. Three children with CF, one child with PCD and five TD children scored in the clinically significant range for overall.

The analysis of the responses to the questions regarding the children's and their families' sleep and daily habits during the -COVID-19 pandemic are shown in Table 1 and revealed that changes in sleep patterns were more common in TD children ($P = 0.011$) and their families ($P = 0.001$). More TD children ($P = 0.010$) and their family members ($P = 0.002$) than children with CF and PCD and their families were sleeping later than before the pandemic. Children with PCD were meeting friends more frequently than children in the other two groups ($P = 0.005$). The mean daily screen time was 2 h (1–2.75 h) before and 4 h (3–6 h) during the pandemic among children with CF, 2 h (0.62–2 h) before and 5.5 h (3.25–7.75 h) during the pandemic among children with PCD and 2 h (1–3.75 h) before and 5 h (4–6 h) during the pandemic among TD children. An increase was observed in all three groups with no statistically significant difference between them. Weight changes were observed in 33% of the children with CF, 75% of the children with PCD and 63% of the TD children ($P = 0.005$). Of those, all the children with CF who experienced weight change, 91% of the children with PCD who experienced weight change, and 95% of the TD children who experienced weight change had gained weight.

No correlations were found between SDSC scores and BMI *z*-scores and PFT results of children in both children with CF and PCD.

## Discussion

COVID-19 has changed people's habits and life-styles all over the world. Although children and adults with chronic diseases are more sensitive to changes and may be affected more profoundly, we found that TD children had more DIMS. Children's but also their parents' sleep habits have changed and we observed that screen time has increased during the pandemic, especially in TD children. We also observed various sleep disorders in children; however, no associations were found between sleep parameters and clinical findings of children with lung disease. We found higher SDB score in children with PCD and higher SHY score in children with PCD and CF.

Insufficient sleep and sleep disorders are associated with poor health outcomes, as they impact mood, daily functioning, cognitive performance and cardiovascular health. Epidemiologic research has shown that the social environment, family cohesion and safety can shape and/or impact sleep patterns, and physical parameters such as light and walkability can influence sleep and are associated with sleep disorders in both children and adults.[18] The COVID-19 pandemic has caused inactivity, social isolation, reduced direct human contact and restricted outdoor activities. This study found changes in the sleep patterns of children and their families, with most sleeping later than before; however, no differences were observed in sleep duration and time to fall asleep after going to bed. These changes were observed more frequently in TD children and their families. This may be because the families of children with chronic condition are behaving more protectively during this period and children with chronic conditions might be more aware of good sleep practises.

TD children had higher DIMS scores than children with CF and PCD. Later bedtime, bedroom activities, lying in bed when not sleeping, bright lights or screens at night, daytime stressors, lack of established exercise and socialisation routines, and lack of exposure to sunlight after waking are risk factors for delayed or irregular sleep patterns and DIMS.[19,20] In this study, mothers of TD children reported that their children were sleeping later, preferred staying at home, tended to sleep with parents more frequently, showed increased devotion to their mothers and exhibited temperament changes during this period, all of which may cause DIMS. Parents of children with chronic conditions may be more aware of the importance of regular sleep habits for their children. Parents of TD children, on the other hand, may be less aware and should be informed by professionals about the importance of regular sleep habits, especially during such difficult times.

Prolonged engagement in online activities and exposure to digital technologies in general have been associated with symptoms of sleep loss and/or depression among young students. Digital environments exert a negative effect on children's and adolescents' sleep, especially when used at bedtime. Several studies have reported significant relationships between electronic device use and sleep variables. Effects include delayed bedtime or longer sleep onset latency, more frequent waking at night, late wake-up time, bedtime resistance, sleep anxiety, sleep-disordered breathing pathologies, SWTD and excessive daytime somnolence.[21–24] In this study, increased screen time during the pandemic was observed in more than 75% of all children. This could cause sleep disorders, which may have a long-lasting impact.

Excessive internet use has been shown to be cross-sectionally related to impaired cognitive functions and reduced brain volume. It has also been found to be directly or indirectly associated with a decrease in verbal intelligence and reduced grey matter development in later stages in children.[25] Although the related long-term effects of the pandemic are unknown, children experienced this pandemic should be followed with respect to these issues.

Weight changes were observed in children in all three groups and were mostly related to weight gain. Staying at home, limiting outdoor physical activity and interruption of the school routine and switching to digital education may result in boredom, which is associated with greater energy intake and may result in weight gain.[26] In addition to boredom, constant exposure to COVID-19-related news and opinions can be stressful. Stress compels individuals to overeat.[26] Decreased sleep duration and quality are also associated with weight gain, which is in turn associated with SDB and obstructive sleep apnea.[27] In this study, the PCD group, which had the greatest weight gain rate, also had the highest SDB score. Prominent upper airway manifestations of PCD may be another reason for SDB in these children.

Night sweats impair sleep quality and contribute to sleeplessness. They can be observed in a wide variety of differential diagnoses, from infectious diseases to neuroendocrine disorders.[22,28] They are also common in respiratory disorders, such as allergic rhinitis, and tonsillitis.[28] Children with CF and PCD had higher SHY scores than TD children, which could be related to their diseases.

Although some studies have associated SDB with pulmonary function parameters in children with CF, no such correlation has yet been established for patients with PCD.[6,29–32] Likewise, we did not find any associations between sleep disorders and clinical parameters of children with lung disease. This may be due to our small sample size and the low rate of patients who were able to perform a PFT.

Certain limitations of this study should be noted. The study was conducted entirely via teleconference to avoid the risk of COVID-19. Therefore, objective measurements of sleep parameters using polysomnography were not possible due to risk of transmission of COVID-19. Sample size was small and this was an observational study. Longitudinal studies with larger sample sizes should be conducted. Future studies should include objective measurements.

## Conclusions

In conclusion, this study shows that the sleep habits of children and their families have changed during this pandemic. Children with chronic lung diseases may suffer from sleep disorders during this period. Changes in sleep patterns of children and their families and also DIMS were found more frequently in TD children which could be attributed to less awareness of good sleep practises. All these sleep disorders may adversely affect children's development. As the possible long-term consequences are not known at this time, children with lung disease and also TD children should be closely monitored.

## Ethical Approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. This study was approved by the Ethics Committee of the Faculty of Medicine (Date: July 6, 2020, No. 414). Written permission to use the validated Turkish version of the SDSC was obtained from Dr Duygu Akcay.

## References


1 Chokroverty S. The many faces and fangs of COVID-19: An editorial by Sudhansu Chokroverty. *Sleep Med.* 2020; **72**: 164–6.
2 Becker SP, Gregory AM. Editorial perspective: Perils and promise for child and adolescent sleep and associated psychopathology during the COVID-19 pandemic. *J. Child Psychol. Psychiatry* 2020; **61**: 757–9.
3 Shakkottai A, O'Brien LM, Nasr SZ, Chervin RD. Sleep disturbances and their impact in pediatric cystic fibrosis. *Sleep Med. Rev.* 2018; **42**: 100–10.
4 Şişmanlar Eyüboğlu T, Aslan AT, Ceylan A *et al*. Neurocognitive disorders and sleep in children with primary ciliary dyskinesia. *Pediatr. Pulmonol.* 2018; **53**: 1436–41.
5 Cohen-Cymberknoh M, Atia O, Gileles-Hillel A, Kerem E, Reiter J. Sleep disorders in patients with primary ciliary dyskinesia, cystic fibrosis with and without pancreatic insufficiency. *Respir. Med.* 2019; **151**: 96–101.
6 Vandeleur M, Walter LM, Armstrong DS, Robinson P, Nixon GM, Horne RSC. How well do children with cystic fibrosis sleep? An actigraphic and questionnaire-based study. *J. Pediatr.* 2017; **182**: 170–6.
7 Vandeleur M, Walter LM, Armstrong DS, Robinson P, Nixon GM, Horne RSC. What keeps children with cystic fibrosis awake at night? *J. Cyst. Fibros.* 2017; **16**: 719–26.
8 Abbott J, Elborn JS, Georgiopoulos AM *et al*. Cystic Fibrosis Foundation and European Cystic Fibrosis Society Survey of cystic fibrosis mental health care delivery. *J. Cyst. Fibros.* 2015; **14**: 533–9.
9 Quittner AL, Goldbeck L, Abbott J *et al*. Prevalence of depression and anxiety in patients with cystic fibrosis and parent caregivers: Results of the International Depression Epidemiological Study across nine countries. *Thorax* 2014; **69**: 1090–7.
10 Behan L, Rubbo B, Lucas JS, Galvin AD. The patient's experience of primary ciliary dyskinesia: A systematic review. *Qual. Life Res.* 2017; **26**: 2265–85.
11 Wise MZ, Glaze DG. *Assessment of Sleep Disorders in Children*. Uptodate. Available from: https://www.uptodate.com/contents/assessment-of-sleep-disorders-in-children?search=sleep%20children&source=search_result&selectedTitle=2~150&usage_type=default&display_rank=2 [Accessed 1 July 2020].
12 Vandeleur M, Walter LM, Armstrong DS, Robinson P, Nixon GM, Horne RSC. Quality of life and mood in children with cystic fibrosis: Associations with sleep quality. *J. Cyst. Fibros.* 2018; **17**: 811–20.
13 Lee TW, Brownlee KG, Conway SP, Denton M, Littlewood JM. Evaluation of a new definition for chronic *Pseudomonas aeruginosa* infection in cystic fibrosis patients. *J. Cyst. Fibros.* 2003; **2**: 29–34.
14 Bruni O, Ottaviano S, Guidetti V *et al*. The sleep disturbance scale for children (SDSC) construction and validation of an instrument to evaluate sleep disturbances in childhood and adolescence. *J. Sleep Res.* 1996; **5**: 251–61.
15 Santamaria F, Esposito M, Montella S *et al*. Sleep disordered breathing and airway disease in primary ciliary dyskinesia. *Respirology* 2014; **19**: 570–5.
16 Akcay B, Akcay BD, Hekim BO. Reliability and validity of Turkish sleep disturbance scale for children. *Anatolian J. Psychiatry* 2020; **21** (Suppl.1): 70–7.
17 Romeo DM, Bruni O, Brogna C *et al*. Application of the sleep disturbance scale for children (SDSC) in preschool age. *Eur. J. Paediatr. Neurol.* 2013; **17**: 374–82.
18 Johnson DA, Billings ME, Hale L. Environmental determinants of insufficient sleep and sleep disorders: Implications for population health. *Curr. Epidemiol. Rep.* 2018; **5**: 61–9.
19 Honaker SM, Meltzer LJ. Bedtime problems and night wakings in young children: An update of the evidence. *Paediatr. Respir. Rev.* 2014; **15**: 333–9.
20 Crew EC, Baron KG, Grandner MA *et al*. The Society of Behavioral Sleep Medicine (SBSM) COVID-19 Task Force: Objectives and summary recommendations for managing sleep during a pandemic. *Behav. Sleep Med.* 2020; **18**: 570–2.
21 Dresp-Langley B. Children's health in the digital age. *Int. J. Environ. Res. Public Health* 2020; **17**: 3240.
22 Galland B, Spruyt K, Dawes P, McDowall PS, Elder D, Schaughency E. Sleep disordered breathing and academic performance: A meta-analysis. *Pediatrics* 2015; **136**: e934–46.
23 Bruni O, Sette S, Fontanesi L, Baiocco R, Laghi F, Baumgartner E. Technology use and sleep quality in preadolescence and adolescence. *J. Clin. Sleep Med.* 2015; **11**: 1433–41.
24 Dewald JF, Meijer AM, Oort FJ, Kerkhof GA, Bögels SM. The influence of sleep quality, sleep duration and sleepiness on school performance in children and adolescents: A meta-analytic review. *Sleep Med. Rev.* 2010; **14**: 179–89.

25 Takeuchi H, Taki Y, Asano K *et al*. Impact of frequency of internet use on development of brain structures and verbal intelligence: Longitudinal analyses. *Hum. Brain Mapp.* 2018; **39**: 4471–9.
26 Di Renzo L, Gualtieri P, Pivari F *et al*. Eating habits and lifestyle changes during COVID-19 lockdown: An Italian survey. Version 2. *J. Transl. Med.* 2020; **18**: 229.
27 Hargens TA, Kaleth AS, Edwards ES, Butner KL. Association between sleep disorders, obesity, and exercise: A review. *Nat. Sci. Sleep* 2013; **5**: 27–35.
28 So HK, Li AM, Au CT *et al*. Night sweats in children: Prevalence and associated factors. *Arch. Dis. Child.* 2012; **97**: 470–3.
29 Amin R, Bean J, Burklow K, Jeffries J. The relationship between sleep disturbance and pulmonary function in stable pediatric cystic fibrosis patients. *Chest* 2005; **128**: 1357–63.
30 Lumertz MS, Pinto LA. Sleep-disordered breathing in cystic fibrosis pediatric subjects. *Sleep Sci.* 2019; **12**: 165–70.
31 Oktem S, Karadag B, Erdem E *et al*. Sleep disordered breathing in patients with primary ciliary dyskinesia. *Pediatr. Pulmonol.* 2013; **48**: 897–903.
32 Barbosa RRB, Liberato FMG, de Freitas Coelho P, Vidal PDR, de Carvalho RBCO, Donadio MVF. Sleep-disordered breathing and markers of morbidity in children and adolescents with cystic fibrosis. *Pediatr. Pulmonol.* 2020; **55**: 1974–83.


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