

# Sleep medicine and sleep research in children and adolescents

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## 1. Introduction

Sleep disorders in children and adolescents are a **common problem** that most parents will eventually be confronted with. Sometimes, medical or psychotherapeutic advice is sought, but very often parents try to develop their own strategy for the treatment of their child's sleep disorder. The help of relatives and acquaintances is also often sought, as well as the use of certain "home remedies", applied homeopathy, or paramedical treatments.

Pediatric sleep medicine and sleep research are not yet widely developed, and in Austria there are only a few children's wards ambulances that have so far been equipped for sleep disorders.

This article aims to inform about various sleep disorders, and identify diagnostic and treatment options. Various sleep disorders will be illustrated with **case studies**.

## 2. When does a sleep disorder appear?

**Sleep disorders in adults** are, inter alia, relatively well characterized and categorized by ASDA (*American Sleep Disorder Association*) and ICD (*International Classification of Diseases*). There are more than 80 different sleep disorders and sleep-related disorders listed, and the categorization allows good assignment of the respective disorder.

**Sleep disorders in childhood and adolescence** can often be difficult to order into these classifications, and their characteristics are strongly **age-dependent**. It is essential that a child's sleep disorder also **affects the caregiver** (usually the parents) and substantially disrupts the social and family life. Therefore, in the diagnosis and treatment of children and adolescents there is always the "environment" to be taken into account. Basically, there is an indication for intervention whenever the child's sleep disorder becomes a "**family problem**".

## 3. Sleep necessity and sleep rhythm in relation to age

While the **human fetus** spends most of the

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24-hour day sleeping, the maternal circadian rhythmicity participates to a certain degree, yet that will be lost after birth. A **newborn** sleeps about **16 hours** a day, while sleep stages are initially distributed relatively evenly across the day and night. Under the influence of light and darkness as well as the social environment, the "normal" adult **circadian rhythm** is **well developed** (albeit with great individual variation) **by the sixth month of life**.

Parents often report with great pride that soon after birth, their child "is already sleeping through". Though this is enjoyable for the concerned parents, it must under no circumstances be regarded as a rule to aspire to. Least of all, parents must not be put under pressure by such representations to do the same.

For a **toddler**, the average sleep requirement is about **12 hours** (of which about 1-2 hours midday nap) and in **schoolchildren 10-12 hours**. During **adolescence**, the need for sleep eventually drops to an average of 8 hours.

In **adulthood**, the need for sleep is finally individually very different, with "long sleepers" (up to 12 hours) and "short sleepers" (under 4 hours) as extreme values of the physiological range. In this case, there is no direct link between sleep duration and physical or intellectual performance. Each person has to find out and then adhere as far as possible to the ideal for their sleep quantum.

However, having slept well and well-being after the night sleep are not only dependent on the duration of sleep, but also on the **quality of sleep**.

This especially includes a **regular sequence of various sleep cycles** (NREM sleep stages 1-4 and REM sleep). A disturbance of this normal sequence (for example, by sleep fragmentation) leads to significant impairment of the next day.

Example 1: Children with increased “arousals” (waking up during sleep) have disturbed sleep architecture and - despite normal total sleep time - often show symptoms of a sleep deficit (morning fatigue, concentration problems, difficulties at school). Such a proliferation of “arousals” can be found for example in children with severe atopic dermatitis, patients with Down syndrome, or in the presence of obstructive airway diseases.

#### 4. Sleep disorders – organic or not organic?

As in adults, there is a distinction between organic and nonorganic sleep in children and adolescents. While with rarer organic sleep disorders there is an organic malfunction present which can be objectified by a sleep laboratory study, for non-organic sleep disorders this is not available. Apart from the objectification of sleep onset and maintenance disorders - the sleep lab exam shows in this case normal findings. The distinction between organic and non-organic sleep disorder is possible with certainty only by a **sleep laboratory study**

### Abstract

Sleep disorders are very common during childhood and adolescence; their **prevalence** is assumed to be at **10-40%**. The disorders are linked either to sleep per se (sleep onset or maintenance of sleep) or are pathophysiologic alterations (like obstructive sleep apnea syndrome, hypoventilation syndrome, parasomnia). Just like in the case of adults, one can differentiate between more common **nonorganic** and rarer **organic sleep disorders**. Interestingly, these disorders have so far remained without an adequate diagnosis and therapy, and they have often been seen as “normal”. Only in the recent years have **sleep medicine** and **polysomnography** gained momentum.

The mission of **sleep medicine** is objectification of possible causes of sleep disorders and sleep associated disorders, through different modalities (sleep diary, analysis of the environment, examination in the sleep laboratory) and use of an appropriate therapy. Due to the complexity of sleep disorders, an **interdisciplinary protocol** (family doctor, pediatric specialist, differently specialized physicians, psychotherapist etc.) is needed.

By **adequate diagnosis and therapy**, most sleeping disorders are **easy to treat** during childhood and adolescence. Through therapy, not only the quality of life of the patient is improved (awareness during the day, focus, school performance), but also the social well-being of the whole family. Cooperation of the patient and his or her family is essential for a successful treatment.

(**polysomnography**). However, arising from history and status there are often quite clear indications of the type of sleep disorder.

Example 2: A 3-year-old child is awake at night again and again and comes to his parents' bedroom full of fright. The child forces himself/herself between the parents and then sleeps through soundly and peacefully until the morning. An organic cause is unlikely in such a case and a sleep laboratory testing is generally unnecessary.

Example 3: A 3-year-old child sleeps very restlessly, snoring heavily (even in the parental bed) and is very tired in the morning. In this case, a significant airway obstruction may be present, which can be objectified only by a polysomnographic examination.

#### 5. Non organic sleeping disorders in children and adolescents

Depending on age, there are specific sleep disorders that appear more often.

**5.1. Infancy:** The already mentioned **lack of sleep through the night** is not really a sleep disorder, but a physiological adaptation process. This, however, becomes a problem when it leads to an **excessive demand** of parents (usually the mother), and subsequently leads to **interaction problems**. In this case, education, counseling and, where appropriate, therapeutic intervention are used (see below).

Example 4: A 22-year-old mother has decided to work after maternity leave again. The repeated night waking of her baby is distressing, she feels “whacked” in the morning and overwhelmed in her daily work.

Example 5: An unemployed friend of the same age takes the nocturnal awakening of her baby as a normal event and recovers missing nighttime sleep during the day after (nap).

**5.2. Toddlerhood:** At this age outweigh **fears** associated with various **falling asleep and maintaining sleep disorders** (fear of the dark, fear of being left alone, fear of ghosts, demons, robbers, etc.). These fears may be perpetuated and reinforced by **nightmares**. In later infancy, **enuresis nocturna** can already become a problem (expectations of the parents!).

Also, at this age certain **parasomnias** can already occur (e.g., night terrors-pavor nocturnus, somnambulism, see below). Although they are mostly harmless and usually self-limiting, their observation leads to great concern in the case of the parents.

**5.3. School age:** Among the sleep initiation and maintenance disorders described in infants, school age fears could join in, as well as emotional stimulus



overloads (TV, Gameboy, and PC). Sometimes, the pressure of the need to be well rested the next day to provide adequate performance joins in as well.

In Austria, school start times usually scheduled between 7:30 and 8:00 force children to wake up at a time when they are still sleeping very well. Accordingly, quite a few children are classified by their parents as "not a morning person".

Example 6: A 10-year-old boy spends several hours every night playing computer games. Due to the "sensory overload" he cannot fall asleep afterwards. Out of helplessness, parents allow the boy to watch TV with them for a long time, until he eventually "breaks down" at midnight. The next morning, he is hardly able to get out of bed, and the teacher complains of his inattention and poor performance in school.

**5.4. Adolescence:** At puberty, the entire daily routine is usually changed fundamentally. This "rearrangement" usually involves staying up longer at night, thereby usually bringing along morning fatigue, longer sleeping in and staying up on weekends and holidays, and thus the loss of a daily routine. This "irregularity" often leads to sleeping problems during the school/ work week with resulting performance degradation.

## 6. The sleeping problem – a problem of the whole family

Sleep disorders are particularly difficult when several members of a family suffer from one, or the sleep disorder of a child subsequently leads to a sleep disorder of the parents (usually the mother). In such a case, the victims are often close to "despair" and the sleep problem may be the central theme.

Example 7: After a surgical procedure, a 3 month old baby will wake up several times each night. The very worried mother can therefore sleep poorly at night and she is also hardly resting during the day. Because of "palpitations" the doctor will eventually prescribe a beta-blocker and this will lead to a further aggravation of the sleep problem. The young woman will try to go to bed earlier and earlier in the evening, but has difficulties falling asleep and sleeping through the night. Taking the advice of her partner, she visits a gym in the evening, before going to bed.

In this case, several things were done wrong at the same time. Through talk therapy, discontinuation of the (insomnia promoting) beta-blockers, time management in consultation with the partner, and routing of physical activity in the afternoon, a clear improvement of the problem was achieved after a few weeks, and the young woman took "new courage".

## 7. Arousal disorders

These disorders occur from a **deep sleep** (NREM stage 3 or 4). They are often characterized by a positive family history, child's amnesia of the event, as well as by heavy arousal efforts during the episode. The duration of these events is usually a few minutes.

7.1. Sleepwalking (somnambulism, quiet sleepwalking): children seemingly walk aimlessly or stand suddenly disoriented in their parents' bedroom. Rarely, dangerous situations arise by climbing on windows, balcony railings, etc.

7.2. Confusional arousal: the child appears awake but disoriented, and often speaks in a "confused" manner.

7.3. Pavor nocturnus (Night terrors): the child is often very agitated, often screaming, with a fear distorted face, hardly reacting to soothing words.

In particular, the night terrors lead to parents' concern. Education about the nature and the self-imitating nature of the nightly "attacks" is therefore essential.

## 8) Organic insomnia and other sleep associated disorders:

Organic sleep disorders and sleep-related functional disorders are, in contrast to the non-organic sleep disorders, mostly **objectified by polygraph studies in the sleep laboratory**. Here, only the most important of these disorders are listed.

8.1. Central sleep apnea syndrome: increased or prolonged respiratory pauses during sleep occur mainly in preterm infants or in diseases of the CNS (e.g. Arnold Chiari malformation, Joubert syndrome). Treatment with respiratory stimulant drugs (theophylline, caffeine, doxapram) or mechanical ventilation is indicated only in severe forms.



*Examination of a newborn in the sleep laboratory. Different electrodes and sensors measure physiologic parameters such as EEG, EOG, EKG, heart rate, respiration, CO<sub>2</sub> in the expired air, and movement. Through synchronized video recording, the behavior of the child can also be analyzed.*

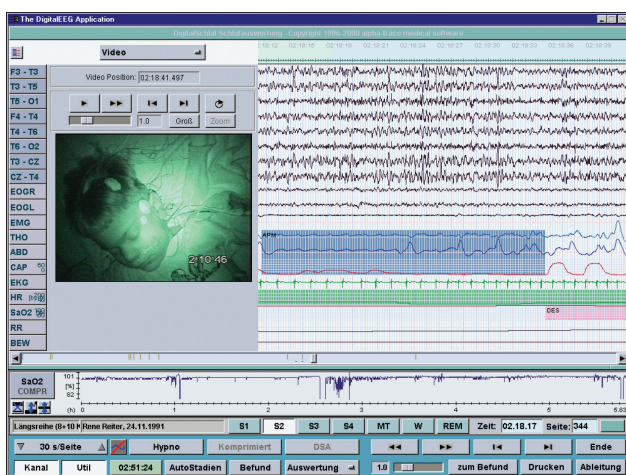


Example 8: A previously healthy 15 year old girl is sent for investigation in the sleep laboratory for nocturnal restlessness. The full picture of a severe central apnea syndrome with salve-like breathing pauses occurring up to 30 seconds is revealed. For further clarification, a MRI of the brain and spine is performed, which leads to the diagnosis of Chiari I malformation with displacement of the cerebellar tonsils into the upper cervical spinal canal.



*Epigastric tonus is an indicator of labored breathing and through that of the existence of a respiratory airway obstruction during sleep.*

8.2. Obstructive Sleep Apnea (OSA): Obstructive sleep apnea resulting from a **mismatch** between the required air flow in the respiratory tract and length or elasticity thereof. The disease is favored by **hypertrophic adenoids and/or tonsils**; the **loss of tone** of the airways during sleep is also responsible. Various syndromes (Down, Franceschetti, Pierre-Robin, Prader-Willi) and metabolic disorders



*Mixed apnea with the duration of 23 seconds in a 10 year old boy, correlated to a slight decrease of O2 saturation. The mixed breathing pause starts as central apnea (missing thoracic [THO] and abdominal [ABD] breathing), after 11 seconds, thoracic and abdominal breathing appear. Nevertheless, for the next 12 seconds, the nasal air flow [CAP] is still missing, as an expression of the airway obstruction.*

(mucopolysaccharidoses, hypothyroidism) are often associated with OSA.

**Noisy breathing, inspiratory retractions, increased breathing efforts, hypoxemia and hypercapnia** characterize the clinical symptoms.

The confirmation of OSA diagnosis is polysomnography.

Therapeutic success is often achieved by **adenotonsillectomy**, and rarely more serious interventions (CPAP, tracheostomy) are required.

If left untreated, severe OSA will not only lead to **daytime fatigue, lack of focus and impaired daily function**, but also to long-term **anatomical changes** (anatomical malformation in the respiratory tract, right heart hypertrophy).

Example 10: a 13-year-old boy's parents have been observing for several months a pronounced respiratory obstruction during sleep and very noisy breathing in their child. They present with the fear that the child "could suffocate". Also, there is often



*Negative pressure ventilation in a child with tracheobronchial malacia. The negative environment pressure around the thorax keeps the airway open (retroversion of the CPAP principle). Polysomnography checks the necessary pressure as well as other necessity of this type of therapy.*

daytime sleepiness with difficulty in focusing. The polysomnography results show obstructive apneas of up to 21 seconds, a drop in oxygen saturation to 80% and sleep fragmentation. After performing adenotonsillectomy, increased ETCO<sub>2</sub> and pCO<sub>2</sub> values still appear for several months, (primarily as an expression of long time adaptation), but otherwise the results are normal.

8.3. Hypoventilation: hypoventilation during sleep can be either **congenital** (congenital central hypoventilation syndrome, CCHS, Undine syndrome) or secondary **acquired** (e.g., after brain tumors or operations, Duchenne's muscular disease). In the foreground there is the **CO<sub>2</sub>**

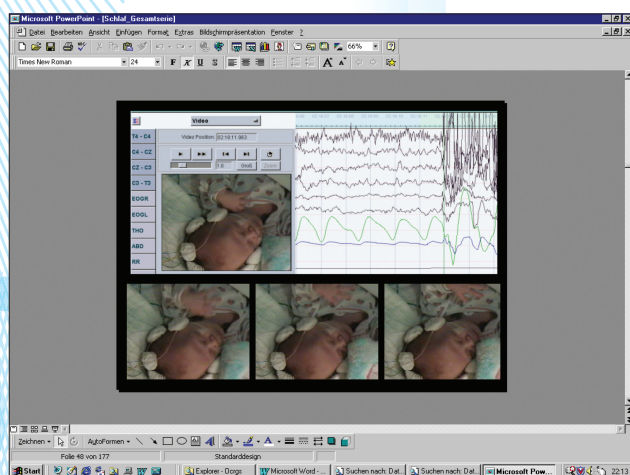


**increase (hypercapnia)** during sleep, and in severe cases also hypoxemia.

Therapeutically, positive pressure ventilation comes into consideration, and for centrally induced hypoventilation there is the possibility of implantation of a diaphragm pacemaker. Very rarely, a negative pressure ventilator or respiratory support is applied (closed chamber with pressure levels under the atmospheric pressure envelops the entire body except the head = reversal of CPAP principle).

8.4. Sleep associated cerebral seizures: These seizures can be well objectified by polygraph **EEG** recordings, possibly with synchronous video recording, and then an adequate anticonvulsant therapy can be applied.

Example 9: A two-month-old infant is assigned with suspected "seizures with waking up from sleep"



*EEG-electrodes as well as synchronous video recording show non-dangerous clonic movement as the cause for jerking movement that wakes the child up, and exclude seizure activity.*

to polygraph. However, multi-channel EEG and synchronized digital video recording show harmless clonic movement, so there is no therapeutic consequence.

8.5. Narcolepsy: This disorder, caused in part by genetic background (HLA-DR2 and DQw1 antigen) is characterized by a **sudden paroxysmal need for sleep. Sudden loss of tone (catalepsy)** is usually part, sometimes also the first symptom of this disease. It usually manifests itself in the second decade of life, but sometimes even in earlier childhood. **Polygraphy** shows the characteristics of the REM sleep (sleep-onset REM) immediately after falling asleep. The disease is treatable with medication (modafinil).

8.6. Restless leg syndrome (RLS) and periodic limb movements (PLM): Although these two disorders are more likely to occur in adulthood, they are observed sporadically in childhood and adolescence. RLS is characterized by leg pain

occurring during rest and at night, also leading to insomnia. Polygraphy shows increased **activity in the EMG** of the tibialis anterior. The syndrome is treated with medication (L-dopa, dopamine agonists).

## 9. Contacts in the case of child and adolescent sleep disorders

As mentioned in the introduction, concerned parents look for advice and assistance in very different places and institutions (family, social circle, family physician, pediatrician, psychologist, psychotherapist, books/brochures, Internet, paramedical workers, etc.) and mostly get well-intentioned but not proper advice.

For **non-organic sleep disorders**, it seems purposeful that the pediatrician caring for the child or the family physician acts as the primary contact; she/he takes over the function of a gate keeper (self-care, or forwarding to sleep medicine entities in appropriate indication).

Physicians caring for children and adolescents should know about the occurrence of sleep disorders at this age, and therefore be there for the parents as competent discussion partners.

If an **organic sleep disorder** is suspected, the patient should be sent to a department with a sleep medical clinic to perform a **polysomnography**.

## 10. The most important rules of sleep hygiene

Only by consistently following these guidelines in many of the cases, can a significant improvement be achieved, but never from one day to another. The treatment of pediatric sleep disorders takes patience and consistency.

1. Pleasant climate, calm (not remote) room, good bed
2. Own bed near the parents' bedroom
3. Not a completely darkened room
4. Controlled going to bed without large temporal fluctuations
5. No stress before bedtime (television, computer games, etc.)
6. Discuss any fears
7. "Finish" the day (going to bed rituals: e.g. bedtime story, evening prayer)
8. No threats ("If you do not sleep ....")

## 11. Related diagnosis and therapy of sleep disorders

The polysomnographic diagnosis and treatment of **organic sleep disorders** has already been mentioned above. The diagnostic and therapeutic opportunities for **nonorganic** sleep disorders are briefly presented below.

**11.1. History clarification:**

11.1.1. Somatic history and evaluation of the sleep behavior through the use of a "sleep diary"

- ⇒ How much does the child sleep at night, how much during the day?
- ⇒ Is there a regular sleep pattern?
- ⇒ How long does the child need in order to fall asleep?
- ⇒ Where does the child fall asleep?
- ⇒ How often does he/she wake up at night and what interventions are used?
- ⇒ What do the parents do to assist with sleeping?

11.1.2. Clarification of the family situation, possible psychopathology of the parents, and child's experiences and characteristics

- ⇒ Information on pregnancy and birth
- ⇒ What are the reasons parents assign their child's sleep disorder to?
- ⇒ How often do they reach the limits of despair?
- ⇒ How is the housing situation? (Size of the apartment/where is the cot/ ...)
- ⇒ Screening for parental well-being (depression problems of the partner/social support/...)

**11.2. Exploration with the child**

Of course, depending on age, work with the child is needed in order to obtain more information. Measures and options in this regard include:

11.2.1. Drawings: Children do not like to formulate judgments about their family or about their lives, about fears and sorrows. Therefore, one should try to obtain information from drawings (interpretation of the points graphical space/ dimensions/colors/animals drawn)

11.2.2. Family structure with figurines: the same as with drawings, it can be done with tridimensional figurines.

11.2.3. Role play: especially father – mother – child play.

11.2.4. "Playing with dolls": "Small world"- Model (doll house)

**11.3. Establishing a "working hypothesis" and therapy planning**

Therapists and parents create a treatment plan with the definition of a "hierarchy":

- ⇒ Where to start first?
- ⇒ Arrange a therapy program (intervention/ duration/ consistency/ ...)
- ⇒ Discuss consequences of therapeutic success (= sleeping through causes affection loss at night, but during the day balanced with appropriate care/elimination of conversation/ ...)

**11.4. Special therapeutic measures**

11.4.1. During infancy:

- ⇒ Informing parents on the normal sleep necessities of the child
- ⇒ Heightened regularity of the daily routine with a maximization of differences between parental behaviors during day and night.
- ⇒ The parents will be educated on the correct supervision of their baby. One should take not only the negative but also the positive events into account.
- ⇒ The child should be offered the possibility of a clear association between environment and different activities.
- ⇒ No stimulating games before going to bed. At this point, soothing rituals should be established (falling asleep rituals).

11.4.2. During toddlerhood:

Starting from the sixth month of life, sleeping disorders are explainable through classic and operative learning models, and therefore also treatable. Behavior therapy methods like extinction and their variants (checking/time-out), shaping etc., can be used in this age group.

Extinction: let the child scream at night (though almost impossible due to social pressure)

Checking: the child will receive a short verbal reassurance from the parents, but no positive reinforcement that has been used so far (like getting the child out of bed).

Shaping: is a gradual approach to the target behavior (the first night, parents go into the room after 2 minutes, the third after 5 minutes, the fifth night after 10 minutes etc.)

11.4.3. School age and adolescence:

Especially during the school age, sleep disorders are often determined by different fears (fear of school, fear of exams, fear of failure etc.). During this age period, an orderly daily routine with no great sleep time variations is to be targeted. Nevertheless, this will completely oppose the interests of adolescents (clubbing during the weekend) and is sometimes only partially attainable. Alcohol and caffeine rich beverage consumption (like energy drinks) should, if possible, be abolished.

**11.5. Medical management**

In clinically healthy children and adolescents, as opposed to adults, pharmaceutical therapy is of less importance and rarely indicated. If sought after, drugs with little side effects should be used, like **phytopharmaceuticals** (valerian, sweet balm, hops).

This article is a translated reprint of the original article: R.Kerbl, A.Köhler, H.Zotter, W.Sauseng, R.Kurz, Schlafmedizin und Schlafforschung im Kindes- und Jugendalter Pädiatrie und Pädologie 1, 14-22, 2003.