



Sleep Disorders in Children

A. A. Schlarb and B. A. Stuck

11.1 Sleep Disorders in Children and Adolescents – 252

- 11.1.1 Sleep and Sleep Development of Childhood and Adolescence – 252
- 11.1.2 Sleep Disorders of Childhood and Adolescence – 255
- 11.1.3 Etiology and Pathophysiology – 260
- 11.1.4 Epidemiology – 261
- 11.1.5 Clinical Presentation – 263
- 11.1.6 Examination Procedures – 263
- 11.1.7 Sleep Medical Diagnostics – 266
- 11.1.8 Differential Diagnostics – 267
- 11.1.9 Insomnia Therapy in Childhood – 267
- 11.1.10 Therapy of Other Pediatric Sleep Disorders – 275
- 11.1.11 Drug Therapy – 275
- 11.1.12 Rehabilitation Measures – 275

11.2 Sleep-Related Breathing Disorders in Children – 276

- 11.2.1 Nonobstructive Sleep-Related Breathing Disorders – 276
- 11.2.2 Obstructive Sleep-Related Breathing Disorders – 278

11.3 Questions – 286

References – 287

Sleep disorders in childhood occur rather frequently. Many typical sleep disorders of adults are already prevalent in childhood or adolescence; others occur typically or exclusively in childhood. Insomnia disorders with difficulties of initiating and/or maintaining sleep are particularly frequent in preschool and primary school children as well as in adolescents. Parasomnia complaints such as night terror (*pavor nocturnus*) and nightmares are also frequently observed in children. The treatment of sleep disorders in children and adolescents is different from that of adults and should be adjusted according to age. This chapter also discusses sleep-related breathing disorders in children, with a special emphasis on pediatric obstructive sleep apnea. Even if the clinical presentation and the pathophysiology of obstructive sleep-related breathing disorders in children and adults are very similar, their treatment differs in various aspects.

11.1 Sleep Disorders in Children and Adolescents

For the development of children and adolescents, sufficient duration of sleep is essential. Thus, besides nutrition and physical activity, as well as regeneration, sleep is considered as a pillar of health. Many children and adolescents, however, do not sleep sufficiently. Other activities in the

evening, such as watching television, playing computer games, or being active in social media, often deprive them of sleep without intention. However, lack of sleep has significant consequences for the psychological and physical development of children and adolescents as well as for their performance in school.

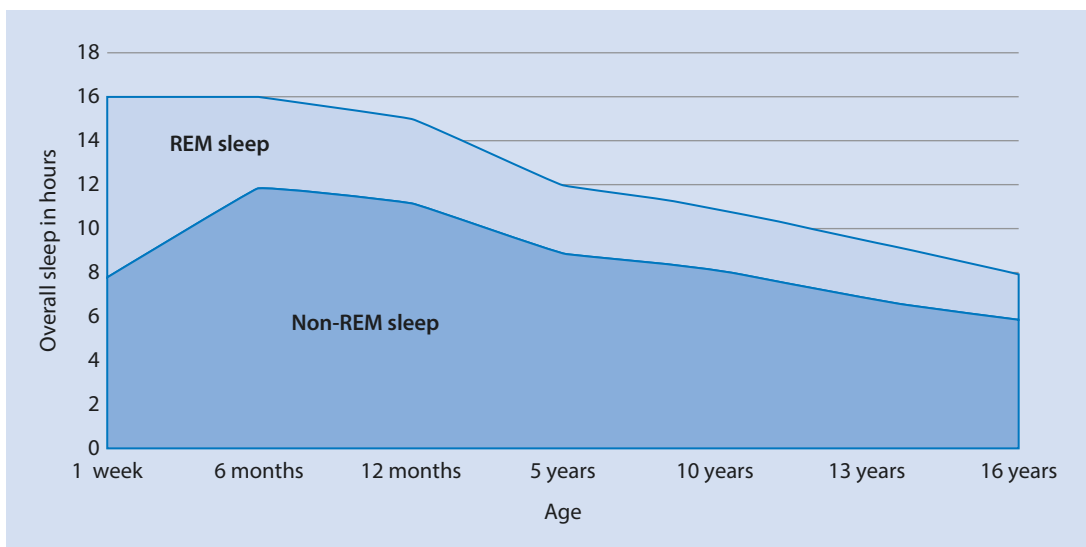
11.1.1 Sleep and Sleep Development of Childhood and Adolescence

11.1.1.1 Development of Sleep

The sleep of newborns is clearly different from that of an adult. After only about 6 months, however, the infants adapt, and their sleep becomes more and more slowly similar to that of an adult. Thus, in newborns the difference is seen between active sleep (AS), which is interpreted as an immature type of the so-called rapid eye movement (REM) sleep, and the quiet sleep (QS) that corresponds to the later deep sleep. Those phases that cannot be clearly assigned are defined as indeterminate sleep (IS).

In infants a few weeks old, active sleep represents the highest percentage of their overall sleep time, approximately 60%. This percentage is reduced in the course of development; at the age of 6 months, active sleep amounts to about 25% of the overall sleep and further decreases thereafter.

■ Figure 11.1 graphically displays the changes.



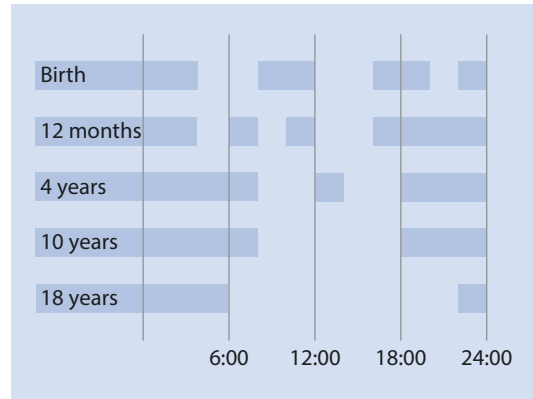
■ **Fig. 11.1** Development of sleep duration and distribution of rapid eye movement (REM) sleep and non-REM sleep depending on age (adapted from to Roffwarg et al. 1966)

As well as sleep duration and the sleep architecture, the length of a sleep cycle also changes. In infants, it is much shorter, 45 to 60 min, compared to adults whose sleep cycle encompasses 80 to 120 min. Furthermore, the respective sleep time until the next longer wake phase amounts to only 2 to 4 h. The following figure depicts the described changes (■ Fig. 11.2).

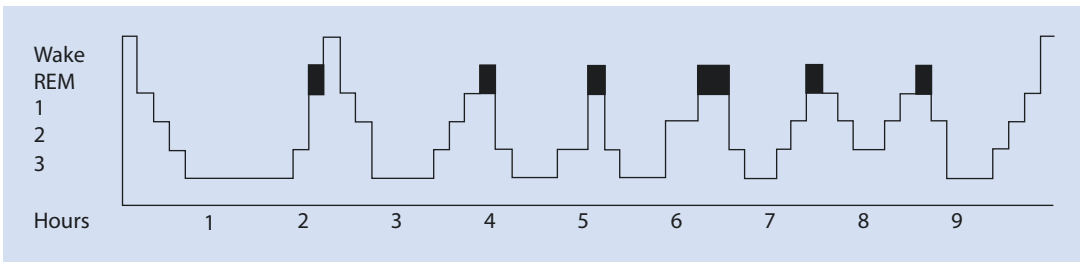
Sleep develops from the polyphasic sleep rhythm to the biphasic rhythm and finally to the monophasic sleep rhythm (■ Fig. 11.3). With maturation and alteration of the sleep-wake rhythm of the child, erroneous associations of initiating or reinitiating sleep may be learned. Instead of sleep-related self-regulation, the infant learns that sleep is only possible under certain circumstances and strongly requests these for initiating or reinitiating sleep (e.g., in the parent's arms, in the presence of one parent, one parent sitting at the bedside, or falling asleep with a baby bottle).

11.1.1.2 Sleep Duration

The following graph shows approximately how much sleep is needed on average, depending on age (■ Fig. 11.4). Young children, of the age of 3 to

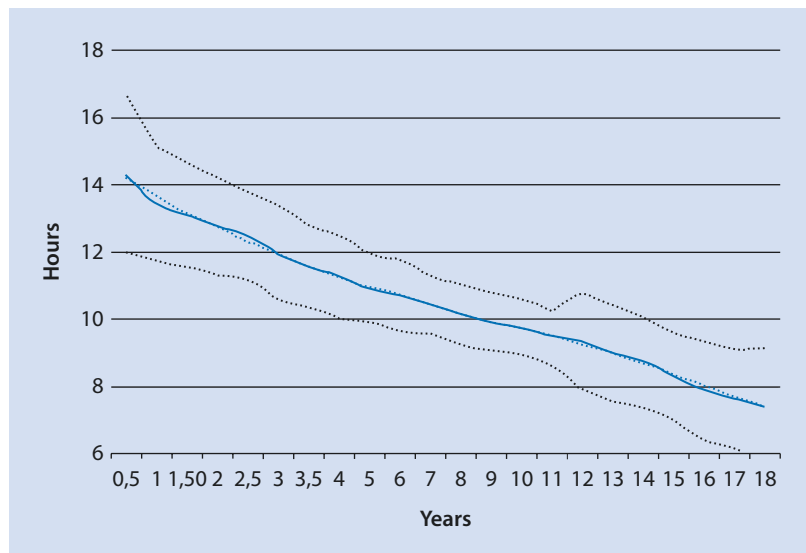


■ Fig. 11.2 Age-dependent changes of the distribution of sleep and wake episodes during 24 h (based on Borbély 2004)



■ Fig. 11.3 Exemplary display of the sleep architecture in childhood

■ Fig. 11.4 Reported sleep duration according to the study results of an investigation of childhood and adolescent health in Germany, depending on the age of the children and adolescents, based on parents' reports or self-reports, respectively. Dotted lines represent standard deviation (SD) (according to Schlarb et al. [22])



4 years, need about 11.5 h of sleep; the necessary sleep time at night continuously declines to approximately 10.5 h until the age of 7 years. During primary school, the average sleep duration decreases again, to 9.5 h, until the age of 10 years. The sleep profile of children reveals that a deep sleep phase takes place directly before waking up in the morning. If the child sleeps insufficiently, this deep sleep phase is omitted, which leads to various impacts during the daytime.

Many adolescents and adults, as well as pediatricians, however, do not realize that adolescents at the age of 13 years also need about 9 h of sleep (■ Fig. 11.4). During puberty, not only developmental changes are seen on the hormones level; melatonin as a sleep-inducing hormone is generally released later. Adolescents become tired later in the evening and thus go to bed later. However, school still starts early in the morning, and the consequences of short sleep duration are reported as reduced daytime alertness of adolescents. Thus, because of their delayed sleep onset, many adolescents do not get enough sleep and show poorer performance in school compared to when they are rested. A school start later in the morning would lead to a longer sleep duration for adolescents, which was demonstrated by several investigations concerning school starting times.

If sleep deprivation or another sleep problem is present, children often show daytime symptoms that are similar to attention deficit disorders. In addition, some become aggressive, and others have significantly impaired school perfor-

mance. As well as neurocognitive limitations, however, a permanent lack of sleep also seems to be associated with the sequelae of a delayed cerebral maturation so that the development of behavioral control and emotion regulation may be impaired or delayed. Other studies reveal that children and adolescents suffering from sleep deprivation or sleep disorders have altered cortisol release and respond to stressing events with an increased or reduced cortisol reactivity compared to healthy individuals. Thus, sleep deprivation and sleep complaints may even change the hormone balance.

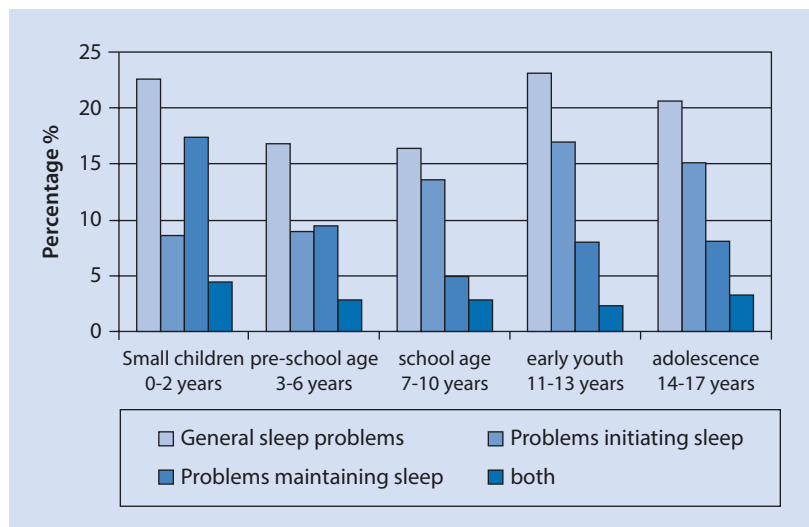
Practical Tip

To assess the individually needed sleep duration, a sleep diary should be conducted for about 14 days during the holidays. The child or adolescent should be allowed to sleep as long as desired during this period.

For assessment of the individually needed sleep duration as well as other sleep-related problems, see also the recommendations for further diagnostics in ► Sect. 11.1.6.

In the different age phases, various symptoms are predominant. At the very early ages, parents report mainly problems of maintaining sleep, but at the time of entering school problems of initiating sleep more prevalent (■ Fig. 11.5). Because sleep problems in childhood and ado-

■ Fig. 11.5 Problems of initiating and maintaining sleep in children and adolescents: results from the KiGGS trial (Studie zur Gesundheit von Kindern und Jugendlichen in Deutschland; Study on children's and adolescents' health in Germany (Schlarb et al. [22])



lescence are more likely to chronify, an early intervention is reasonable and necessary.

11.1.1.3 Parents' Behavior and Impact of Children's Sleep Disorders on Parents

Not only does the child experience the consequences of sleep deprivation or sleep complaints, but the family is also usually involved. After the child's birth, parents generally show changed sleep patterns. Mothers have reduced overall sleep time in comparison to the last third of their pregnancy; for both parents, time awake at night and the incidence of waking up in the nighttime are increased compared to the period of pregnancy. However, this is especially true for the mothers and less so for fathers. Parents frequently suffer greatly because of the infant's sleep problems, which is seen in the increased depressiveness of mothers of young children as well as from their own sleep deprivation. The severity and persistence of infant sleep problems are influenced by the mother's perception to set limits to the child's actions. Other factors are the child's nervous temperament, anxiety of the mother, ambivalent bonding, and intensive active calming such as immediately taking the baby from its bed when awake. Those factors may negatively influence the self-regulation of the sleep-wake rhythm of the child. Thus, during pregnancy, as a prevention not only sleep-related education but also the parents' sleep-related cognitions are discussed to strengthen the parents' ability to handle possible infant sleep problems (see ► Sect. 11.1.9).

To what extent parents influence their child's sleep, in particular in early childhood, by their behavior becomes clear by the early application of active calming that may clearly affect the child's sleep. It is thought that too rapid active intervention of the patients in problems of initiating sleep or waking up at nighttime may impede the child's development or consolidation of self-soothing competence. In contrast, autonomy-enhancing educational strategies, emotional availability, and rituals when going to bed have a calming effect and lead to a high quality of sleep for the child. Thus, the availability of sleep-related educational

strategies for parents an important aspect of healthy sleep behavior in young children.

If the child suffers from sleep problems or disorders, most often the parents also experience significantly impaired sleep. They wake up more frequently at night and often report insufficient and disturbed sleep. Parental sleep deprivation is then often associated with increased stress experiences, a deteriorated state of physical health, as well as an increased risk to develop anxiety disorder or depression, which applies especially for mothers.

As well as the consequences for physical and psychological health, parental partnership is also often affected by these sleep problems. Satisfaction of the partners' relationship is considered to be less when their child does not sleep well. Often, conceptions of the couple regarding the correct strategy for the child's sleep problems differ, which may lead to nighttime disagreements. Thus, unsatisfactory relationships and problems or conflicts of the couple as well as aggression in the partnership are often associated with infant sleep problems.

It should also be taken into consideration that interaction problems with the child occur because the sleep deprivation of the parents may also impair their educational competence, and as a consequence, anger and feeling upset as well as helplessness may come up. In addition, the impaired educational competence of the parents not only becomes apparent at night but is also obvious during the daytime.

11.1.2 Sleep Disorders of Childhood and Adolescence

The most important sleep disorders in childhood and adolescence include insomnia, parasomnia, sleep-related movement disorders, sleep-wake rhythm disorders, and sleep-related breathing disorders. In this chapter, these diseases are presented with a special focus on insomnia complaints. In this context, it should be noted that earlier chapters are dedicated to parasomnia (see ► Chap. 7), movement disorders (see ► Chap. 8), and sleep-related breathing disorders in childhood (see ► Sect. 11.2).

Frequent Disorders in Childhood and Adolescence

- Insomnia (disorders of initiating and maintaining sleep)
- Nightmares
- Night terror (pavor nocturnus)
- Sleep-related movement disorders
- Sleep–wake rhythm disorders
- Sleep-related breathing disorders

11.1.2.1 Insomnia in Childhood and Adolescence

Acute Insomnia/Short-Term Insomnia

According to ICSD-3, a short-term insomnia with problems of initiating or maintaining sleep in children and adolescents is generally classified as pathological and sleep disturbed when the duration of initiating or reinitiating sleep is extended (orientation value, 20–30 min), when the child resists going to bed at the scheduled time, wakes up early in the morning, or needs the parents' help to go to sleep, and when all these concerns have appeared several times per week (at least three times per week) during the past months. The child or adolescent suffers from impairment during the day such as fatigue, daytime sleepiness, concentration or memory problems, or problems with school performance, and emotional irritability, behavioral problems (e.g., hyperactivity, impulsiveness, aggressiveness), reduced energy or motivation, an increased number of accidents, or dissatisfaction with sleep. The reported sleep problems, however, cannot be explained only by insufficient possibilities (e.g., there is not enough time to sleep) or adverse circumstances (e.g., insecure, bright, loud, or inappropriate environment).

Diagnostic Criteria of Insomnia in Childhood and Adolescence

- At least one of the following symptoms must be present several times per week:
 - Prolonged duration of initiating or reinitiating sleep.
 - Resistance when going to bed.
 - The child needs parental help or support to initiate or reinitiate sleep.

- Impaired daytime alertness such as sleepiness, hyperactivity, behavioral disorders, or learning difficulties is observed.
- The sleep problems are not caused by insufficient possibilities or adverse circumstances.
- The sleep problems cannot be explained by another sleep disorder, medical, neurological, or psychological disease, drug intake, or substance abuse.

Chronic Insomnia

If these sleep problems and their consequences persist over 3 months, chronic insomnia is diagnosed. The DSM-5 also includes the age-specific problems of children and adolescents and states that the problems have to occur at least three times per week during 3 months (DSM-5, 2013).

11.1.2.2 Sleep-Related Movement Disorders in Childhood

Periodic movement disorders such as stereotypic head banging, head rolling, or body rolling in particular occur in childhood. The movements start shortly before falling asleep or during sleep and are sometimes accompanied by noises. For diagnosis, video clips recorded by the parents, for example, with a smartphone, may be helpful by showing typical movement behavior. If possible, an examination should be performed in the sleep laboratory (see ► Chap. 2). In severe cases, behavioral therapy is indicated.

In the context of restless legs syndrome (also known as Wittmaack-Ekbom syndrome), children or adolescents report uncomfortable movement sensations of the legs (for further description of the symptoms and treatment recommendations, see ► Chap. 8). The resulting sleep deprivation generally leads to daytime sleepiness, symptoms of hyperactivity, and cognitive performance impairment such as difficulties with concentration.

11.1.2.3 Sleep–Wake Rhythm Disorders

The key problem of sleep–wake rhythm disorders is the discrepancy between one's inner clock and environmental time. The child or adolescent is able to sleep, but not at the “normal” times. Children

and adolescents then have respective problems with getting up at “normal times” (i.e., at 7 AM). One frequently observed consequence is the absence from school or sleeping at school and a lack of attention. In adolescence, such a shift may be caused mainly by activities in social networks, phone calls, or meeting friends late in the evening. Because of the blue-light portion of computer screens, for example, release of the sleep-inducing hormone melatonin is delayed. Furthermore, often the production of the stress hormone cortisol is changed, which is associated with later sleep onset. Based on this rhythm alteration the symptoms of adolescents are frequently called social jetlag.

Delayed Sleep Phase Syndrome

Affected children or adolescents show relevantly delayed times of going to bed and arising for at least 3 months, accompanied by an inability to fall asleep or to wake up at a desired or requested time. If the child or the adolescent is allowed to follow his/her individual need or rhythm of sleep, sleep quality and age-related sleep duration improve with a continuously delayed 24-h sleep–wake pattern. The sleep-related problems should be documented by means of sleep diaries and, whenever possible, actigraphy, each for at least 7 and more than 15 days, respectively. Delay of the normal sleep phases is then detected. Workdays or schooldays as well as holidays have to be taken into consideration in this diagnostic phase. Effects of such sleep problems are often absence from school or relevantly reduced school achievements.

Advanced Sleep Phase Syndrome

This syndrome is defined by advancing the main sleep phase for at least 3 months relative to the desired or requested sleep and waking time. This diagnosis becomes apparent by chronic or recurrent difficulties to stay awake until the desired or requested time, associated with an inability to sleep until the desired or requested wakeup time. Further criteria and procedures regarding the diagnosis correspond to the delayed sleep phase syndrome.

Irregular Sleep–Wake Rhythm

The patient or contact person reports a pattern of irregular sleep and wake episodes during the 24-h day that persists or recurs for at least 3 months. Insomnia symptoms are observed at the planned time of sleep onset (mostly at night) or excessive sleepiness occurs during the day. Further criteria

and procedures in the context of diagnosis correspond to the delayed sleep phase syndrome.

In particular, adolescents and young adults such as university students suffer from these disorders of the sleep phases, especially from the problems of delayed sleep phases. One risk factor in this context is media consumption or the possibility of organizing one’s rhythm freely (studies). The structured and stepwise adaptation to the appropriate time of going to bed is the procedure of choice. Such elements are implemented, for example, in the training concept for adolescents.

11.1.2.4 Hypersomnia

Even if night sleep is perceived as restorative by children and adolescents, they fall asleep during the day without wanting to do so or being able to avoid sleep. The symptoms are mostly associated with significant negative effects on school and leisure time. The main characteristic is an excessive daytime sleepiness with sleep attacks. If no physiological origin is found for the sleep problems, the exclusion of psychological disorders also is recommended.

Two subtypes of childhood hypersomnia are differentiated:

- Idiopathic hypersomnia with long sleep durations
- Idiopathic hypersomnia without long sleep durations
 - In general, these disorders occur rarely compared to insomnia or nightmares.
 - ▶ Chapter 5 covers hypersomnia complaints more comprehensively.

11.1.2.5 Sleep Disorders and Psychological Disorders

Sleep problems or disorders also appear in the context of or in comorbidity with psychological disorders. Frequently, sleep problems play a key role in cases of anxiety disorders, depressive disorders, attention deficit disorders, and even in conduct disorders (CD). Up to 52% of the children and adolescents with insomnia also have psychological diseases. Such comorbid symptoms should imperatively be taken into account because they most frequently enhance the symptoms and significantly impair the quality of life of the child or adolescent.

Anxiety Disorders and Sleep Problems

Children suffering from anxiety disorders and children with separation anxieties display sleep problems more frequently. Emotionally unsure children

often need their parents to initiate or reinstate sleep at night. With their distress associated with the separation situation, the children experience a physiological arousal, which then significantly impairs reinitiating sleep. Typically, those sleep problems are observed in the context of anxiety disorders between the ages of 6 and 20 months. The child tries to avoid being alone and thus also sleeping alone. About 90% of the children with separation anxiety display at least one sleep problem.

Depression and Sleep Problems

Another group of internalized disorders that are often associated with sleep complaints in childhood are depressive diseases. Although such disorders only rarely occur in early childhood, many adolescents show severe symptoms of depression. Often the affected children or adolescents report sleep problems. Besides difficulties of initiating and maintaining sleep, often also an increased need for sleep is observed with the simultaneous perception of not feeling rested. Adolescents report typical concerns and negative cognitions frequently. However, those cognitions and feelings are not limited only to sleep but are comprehensive with regard to the future, the world and environment, and one's own self (cognitive triad). Increasingly occurring nightmares are considered as an important factor for the development of suicidal thoughts and suicide attempts of adolescents.

Posttraumatic Stress Disorders and Sleep Problems

Experiencing traumatic events leads to severe symptoms, not only in adults. Younger children of preschool age generally show not only clear avoidance and anxiety behavior but also especially frequent nightmares and sleep disorders, in particular disorders of initiating and maintaining sleep. Approximately 70% of the children and adolescents with PTSD suffer from recurrent nightmares. Both sleep disorders (insomnia and nightmares) are attributed to changed hyperarousal that counteracts relaxing and thus also falling asleep.

Attention-Deficit/Hyperactivity Disorder and Sleep Problems

Parents of children suffering from attention-deficit/hyperactivity disorder (ADHD) often report the high level of activity of their children and respective problems in the context of going to

bed. Furthermore, these children frequently suffer from daytime sleepiness and insomnia symptoms. Besides these problems, increased snoring is observed in some of those children (2.2 times more frequently than in healthy individuals). Occasionally a correlation of lack of sleep, daytime sleepiness, hyperactivity, and inattentiveness is discussed because tired children show similar behavior as children with ADHD symptoms. The vicious circle of sleep pressure (■ Fig. 11.6) tries to describe this dynamism. In comparison to healthy children, children with ADHD often suffer from continuously recurring sleep-wake problems with alternating problems of initiating sleep, sleep duration, and sleep efficiency. Considering the subtypes of ADHD, children with hyperactive-impulsive symptoms show the most severe sleep complaints, whereas children with predominantly inattentive behavior rather suffer from daytime sleepiness, nightmares, and unwillingness to go to bed. Children with mixed symptoms (hyperactivity and inattentiveness), however, more frequently suffer from sleep-related breathing disorders. Both subtypes (hyperactive and mixed symptoms) are often accompanied by waking up early in the morning in contrast to attention-impaired children.

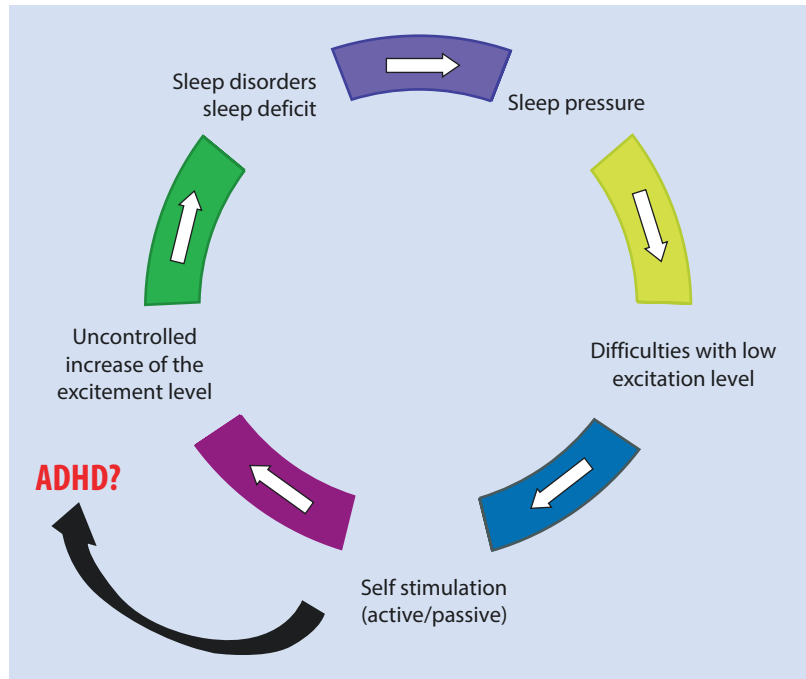
Emotion Regulation and Sleep

Lack of sleep is often attended by a depressed mood and reduced capacity of adaptation in the context of emotional events. A higher level of daytime sleepiness in children is associated with negative emotional reactivity, low frustration level, as well as less positive emotional reactivity. Children who are sleep deprived, or sleep less than they need, are more irritable and more rapidly frustrated. Sleep deprivation not only reduces the positive affections of children and adolescents but also increases anxiety. Good quality of sleep, however, is associated with emotional balance.

Aggression and Sleep

Not only sleep deprivation but also insomnia symptoms and nightmares are closely related to the increased aggressive behavior of children and adolescents. Children sleeping less than needed and suffering therefore from sleep deprivation, cannot control their frustrations very well, and are more likely to show aggressive symptoms in cases of frustration. Although this is expressed in children as crying and tantrum, older children

■ **Fig. 11.6** Vicious circle of sleep pressure in children and adolescents suffering from attention-deficit/hyperactivity disorder (ADHD) symptoms (adapted from Rabenschlag 2001)



are often aggressive toward their peers or may damage objects. Auto-aggressive behavior, up to even suicidal developments, may be summarized under this phenomenon. These behaviors predominantly occur in adolescence.

Autism and Sleep

Autism, a severe development disorder displayed by deficits of social interaction and communication as well as limited repetitive behavioral patterns, is a rare disease with relationship to anxiety or depressive disorders. Children with autism spectrum disorders clearly suffer more frequently from sleep problems than healthy individuals, with a prevalence of 80%. The most frequent disorders are insomnias (80%) and parasomnias (53%). A higher portion of sleep problems is generally associated with reduced daytime alertness and functionality, with more externalized problem behavior, and with more, and more severe autism symptoms.

11.1.2.6 Sleep Disorders and Other Comorbid Disorders

Epilepsy and Sleep

Children and adolescents with epilepsy often suffer from sleep problems. Most frequently, these children and adolescents suffer from sleep-related breathing disorders, waking up at night, and

excessive daytime sleepiness. A higher rate of parasomnias, shorter sleep duration, reduced efficiency of sleep, and sleep-related anxiety are also found to a larger extent in epileptic children. The consequences of sleep deprivation or daytime sleepiness can be seen in relationship to epileptic seizures. Furthermore, these sleep problems are closely related with the degree of seizure control.

Headaches and Sleep

Children who are affected by headaches also suffer from sleep problems more often than do healthy children. In addition, further psychological complaints and stress contribute to the maintenance of both problems. Some findings seem to confirm that both groups of complaints are based on common metabolic anomalies and neuroendocrine particularities, so that combined treatment of headaches and sleep seems to be reasonable. Although little is known about the effect of headache treatment on sleep problems or of sleep treatment on headaches in children, an implementation of this correlation in the therapy seems to be reasonable.

Atopic Dermatitis and Sleep

Atopic dermatitis (AD) or atopic eczema mostly occurs in early childhood and is associated with reduced quality of life for the affected children.

Children and adolescents with neurodermatitis suffer from sleep disorders more frequently than healthy peers. Several trials could show that children with atopic dermatitis often have a prolonged sleep-onset latency. Furthermore, they frequently reveal a reduced sleep duration and efficiency; that is, they sleep too little and the quality of their sleep is impaired. Also, sleep fragmentation often enhances the present symptoms of AD. In this context, it must be taken into account that the severity of the disease has a direct impact on the child's sleep. This kind of sleep impairment is then closely related to manifold impairments during daytime so that these children frequently report attention problems, problems with school achievements, and further consequences.

Functional Abdominal Pain and Sleep

The correlation of ambiguous abdominal pains and sleep has been investigated less intensively and does not seem to be so important as that of headache diseases and sleep in children and adolescents. Of children and adolescents who suffer from recurrent abdominal pain (RAP), only about 25% perceive their sleep as good, whereas nearly 90% of healthy individuals are satisfied with their sleep. Furthermore, children with RAP often (about 30%) report that abdominal pains occur before falling asleep or that they wake up at night because of these pains. These children suffer more severely from sleep problems, insomnia symptoms, and nightmares as well as increased daytime sleepiness compared to healthy children. It must be taken into consideration that objective data (actigraphy) do not reflect these observations. Overall, children with RAP have a significantly higher risk to develop sleep disorders. The inverse correlation is also true: children who regularly do not sleep well have a 2.8-fold risk to develop regular stomachaches than children with a high quality of sleep.

Chronic Inflammatory Bowel Disease and Sleep

Chronic inflammatory bowel diseases (IBD) are also associated with poorer quality of sleep. So far only a few trials have been published on Crohn's disease or ulcerative colitis and sleep in children and adolescents. These study results, however, indicate that according to the parents' reports, affected children and adolescents suffer significantly more often from sleep problems, nightmares, an increased need for sleep, and more

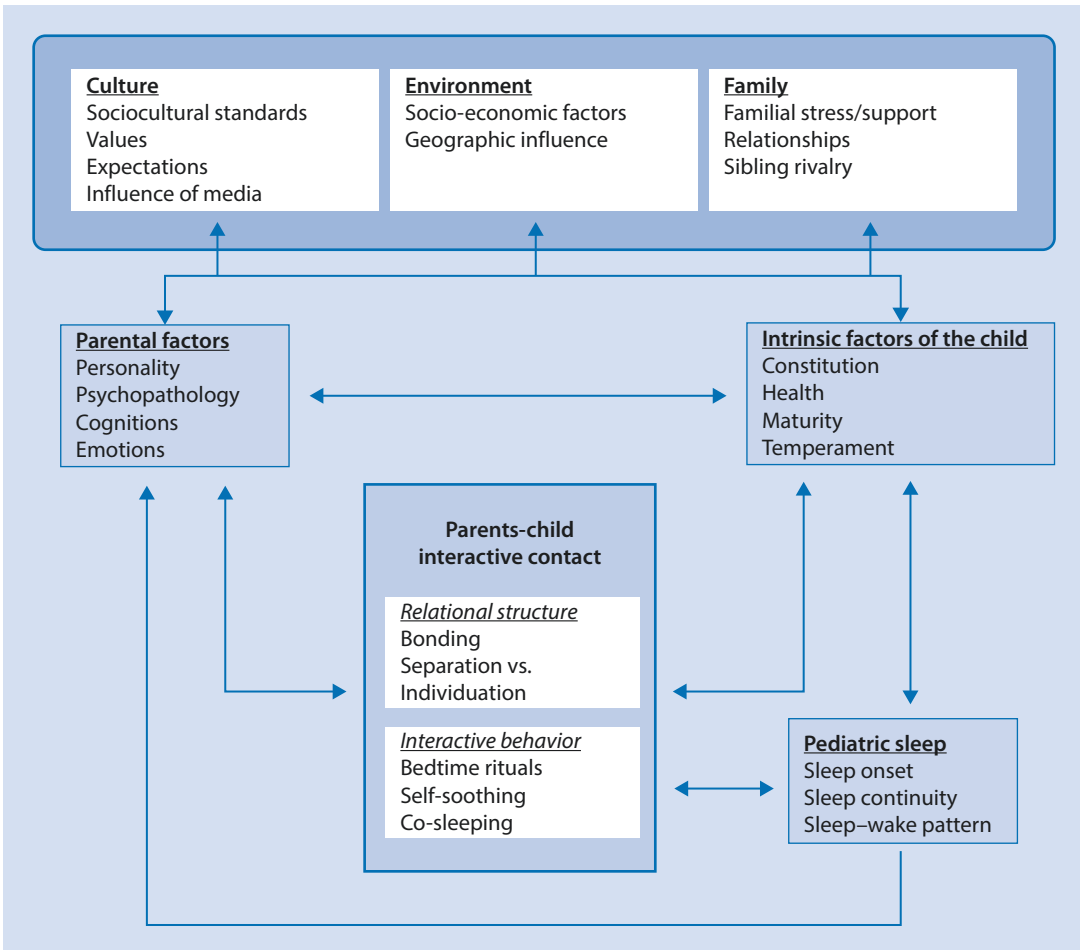
daytime sleepiness compared to healthy peers. About 20% of adolescents with chronic IBD report sleep problems, and approximately 40% of them additionally suffer from anxiety problems and depressive symptoms, whereas only 16% of adolescents with chronic IBD without sleep problems reveal such emotional difficulties.

In summary, it can be stated that sleep disorders and comorbid disorders interact. As shown by the aforementioned comorbidities, these types of sleep disorders in these combinations tend to chronify. Sleep disorders in children and adolescents accompanied by psychological disorders such as depression, anxiety, ADHD, or also headaches, recurrent abdominal pain, irritable bowel syndrome, or chronic inflammatory bowel diseases are frequently observed and seem to reciprocally influence each other. An existing sleep disorder may increase the risk of psychological or somatic complaints by fourfold to even sevenfold.

11.1.3 Etiology and Pathophysiology

Sleep disorders in children and adolescents are influenced by various *multifactorial influencing factors*. Depending on the appearance of the disorder, sleep disorders have rather a physiological origin, or they result from manifold psychological and family-related influences. Children with chronic diseases (e.g., atopic dermatitis, rheumatic diseases, chronic headaches, chronic inflammatory bowel disease) are subject to other influencing factors compared to those with psychological disorders (anxiety disorders, ADHD, CD) or those without additional diseases. This correlation must be considered in the context of diagnosis and treatment. Furthermore, *age* is crucial concerning the influencing factors with regard to the origin and maintenance of sleep disorders. Factors such as the elimination of daytime sleep phases, immaturity of vigilance transitions, or physiological and development-associated changes of the NREM quantity of sleep may lead to increased occurrence of parasomnia in children 3 to 7 years old (see ► Chap. 7).

In young children with problems of initiating and maintaining sleep, for example, other factors may be effective compared to adolescents who also suffer from multiple puberty-associated factors. ■ Figure 11.7 displays a model of influencing factors for children of young ages.



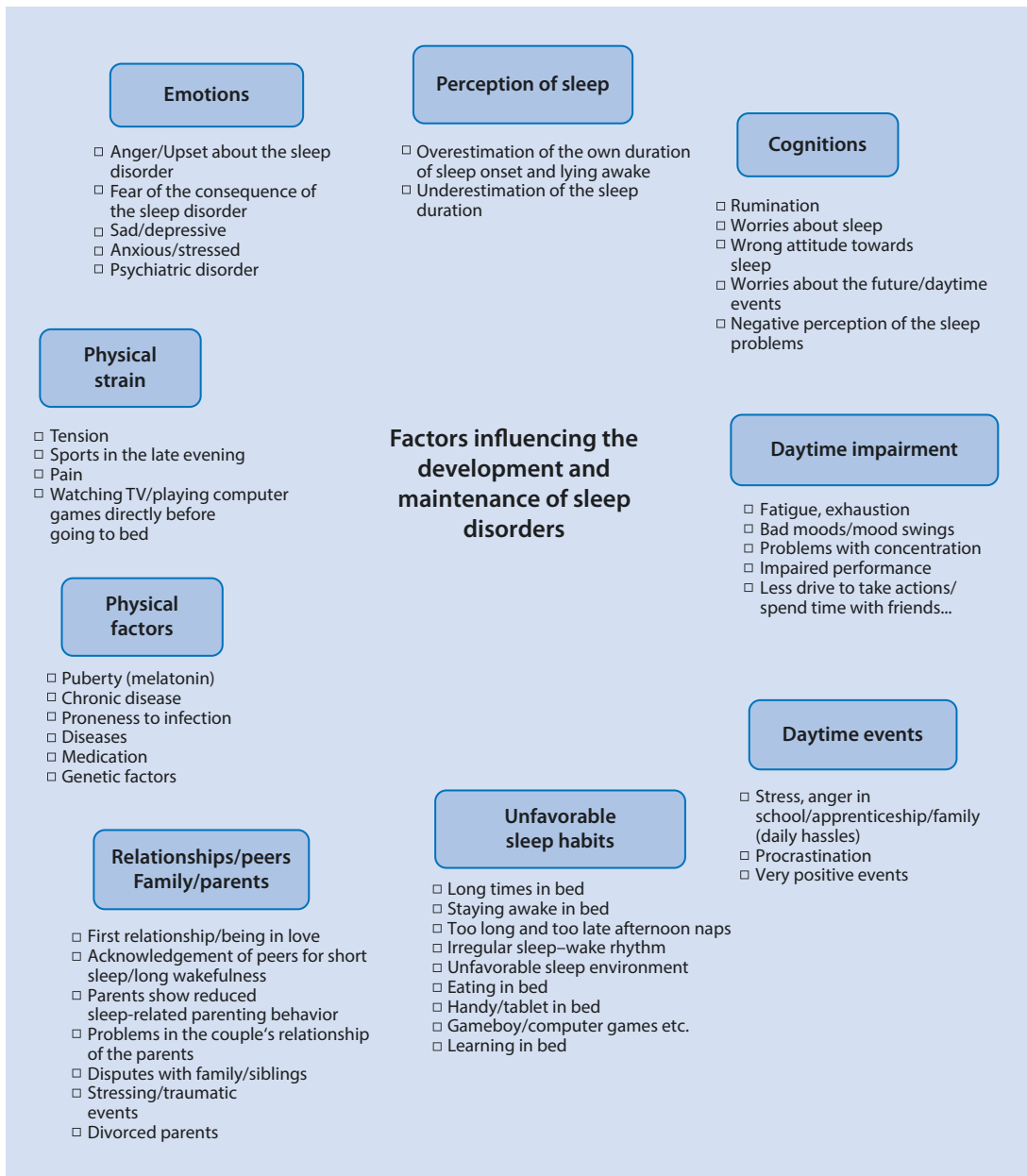
■ Fig. 11.7 Adapted model of sleep-wake regulation according to Sadeh and Anders [10], as well as Cattarius and Schlarb (2016)

A specific model for adolescents, however, should emphasize other factors. The model displayed in the following figure takes this requirement into account (■ Fig. 11.8).

11.1.4 Epidemiology

Between 15% and 25% of preschool children and schoolchildren are affected by problems of initiating and maintaining sleep. About 25% of all children suffer from sleep disorders in the course of their childhood or adolescence. Problems of initiating and maintaining sleep (insomnias) are the most frequently observed disorders. Approximately 20% of the children have general sleep complaints, about 17% of young preschool children suffer from complaints of maintaining sleep, and about 14% of the

schoolchildren have difficulties with initiating sleep. Often the parents are involved in dynamic of the sleep disorders of younger children, because the children need their parents to reinitiate sleep, whereas adolescents often lie awake in their beds at night or occupy themselves with media such as smartphones. About 10% to 30% of adolescents suffer from acute insomnia; about one third even suffer from several insomnia symptoms. Findings with regard to a gender-specific risk to develop insomnia are often contradictory. Trials oriented at sexual maturity show no differences between boys and girls (before the onset of menarche) regarding insomnia. With the onset of menstruation, the risk for girls increases threefold. With increasing age, adolescents show more preference for late evening hours and going to bed later as a consequence of puberty, but this is often associated with increased daytime impairment.



■ **Fig. 11.8** Influencing factors for the development and maintenance of sleep disorders in adolescents (see JuSt [22])

Symptoms such as excessive daytime sleepiness may also indicate other existing sleep problems or insufficient sleep. Between 16% and 40% of adolescents suffer from such daytime sleepiness. About 35% of adolescents have difficulty in waking up in the morning, and up to 67% report sleep deprivation.

In particular, adolescence is closely related to onset of the circadian rhythm disorder of the delayed sleep phase type (delayed sleep phase disorder, DSPD). Between 0.5% and 7% of adoles-

cents suffer from this disorder. In addition, DSPD in adolescence often leads to the development of insomnia problems. On the other hand, about 10% of adolescent insomnia patients meet the diagnostic criteria of DSPD.

11.1.4.1 Chronification

The frequent assumption that children or adolescents would “grow out” of their sleep disorder is only true to a limited extent because more than

80% of children and adolescents report insomnia symptoms in their histories. Sleep disorders also often have an intermittent course in childhood and tend to resist; several studies even report a persistence of nearly 50% up to adult age. Furthermore, long-term trials confirm that early sleep problems are correlated with later emotional and behavioral problems in adolescence.

Thus, age-appropriate tools are important for early diagnosis that allow asking specific questions to patients in early ages. Not only may a lack of sleep or too much sleep have respective consequences, a therapist for children and adolescents also should be aware that a sleep disorder may be apparent. Therefore, the following paragraph focuses on the possibilities of diagnosing sleep disorders in children and adolescents.

In childhood and adolescence, sleep problems are also widely distributed and have a great impact on the development of children and adolescents. These problems:

- Frequently occur very early.
- Tend to chronify.
- Are risk factors for the physical, emotional, cognitive, and social development of children and adolescents.
- At the same time aggravate already existing medical, psychiatric, psychosocial, and developmental problems and disorders.
- Have a significant influence on the whole family, especially when occurring in children.

11.1.5 Clinical Presentation

Sleep deprivation, insomnia symptoms or insomnias, and nightmares are very frequently observed in children and adolescents and are associated with relevant impairments during the daytime. Young children especially only rarely complain about impaired sleep quality or even daytime sleepiness; rather, such impairment during the daytime is perceived by adolescents or adults. So, most often the parents are addressed in the context of diagnosing sleep problems in early ages. As previously described, children who suffer from sleep deprivation or sleep difficulties often display symptoms of ADHD; therefore, a

differential diagnostic examination is essential. Also, the long-term sequelae of sleep deprivation and sleep disorders are not actually known to the children or adolescents: they do not reflect or realize that they remain clearly below the performance level they would be normally able to achieve and that they experience more disputes and conflicts with peers or family members. Even adolescents are not conscious of the consequences of persisting sleep deprivation, especially in puberty. They do not classify their mood swings as sequelae of lacking sleep or poor sleep hygiene.

Practical Tip

Sleep deprivation and sleep disorders in children are often expressed by hyperactive and inattentive behavior during the day. In children who present with the suspected diagnosis of ADHD, sleep deprivation, insomnia, or another sleep disorder should always be excluded by differential diagnosis and assessed (e.g., by means of sleep diaries or questionnaires).

11.1.6 Examination Procedures

11.1.6.1 History Taking

At the beginning, comprehensive *sleep history taking* by means of sleep protocols and age-appropriate screening questionnaires for children and parents is important to diagnose sleep disorders. In cases of several sleep-specific differential diagnostic questions, an interview may also be performed (see following). Together with the *clinically physical and psychological examination*, the patient's history helps in discovering comorbidities or underlying disorders. A video clip displaying the child's sleep behavior may also contribute to better findings. With only low light (e.g., a bedside lamp), informative sequences may be recorded that allow differentiating between pavor nocturnus disorder and possible epileptic seizure. In adolescents, questions about stimulant intake, and in children and adolescents also questions about drug intake, must be asked, because various pharmaceuticals may lead to sleep problems such as difficulties in initiating and maintaining sleep.

11.1.6.2 Sleep Protocol

To assess sleep deprivation as well as different events during sleep, taking a sleep protocol may be helpful. A 24-h protocol is suitable for infants and children; a normal protocol is suitable that refers to the problems of initiating and maintaining sleep whereas a detailed assessment of the day is not required. In young children, the parents should additionally record a sleep protocol from their own sleep to assess the consequences for parental sleep. Adolescents, however, are mostly better able to report about their sleep than their parents. Therefore, in these ages the adolescents are mostly a better source of information. However, it must generally be taken into consideration that the assessment by the children in comparison to those of the parents may vary, so an evaluation from both the child's and the parents' perspective seems to be reasonable.

By applying screening questionnaires, sleep-related information can be retrieved rapidly and effectively.

11.1.6.3 Questionnaires on Parents' Information

Children's Sleep Habits Questionnaire (CSHQ)

The CSHQ is a questionnaire for parents of preschool and primary school children (4–10 years) intended to screen typical, clinically relevant sleep problems in this age group: difficulties of going to bed, delayed sleep onset, insufficient sleep duration, sleep-related anxieties, waking up at night, parasomnias, sleep-related breathing disorders, and daytime sleepiness. An overall “sleep disturbance score” is calculated as well as eight subscale scores. The original questionnaire in English was evaluated in a clinical and a nonclinical sample.

Sleep Disturbance Scale for Children (SDSC)

The SDSC is a short screening questionnaire intended to identify sleep disorders in children and adolescents. This questionnaire can be completed by the children or adolescents as well as by the parents. Twenty-six items should be answered on a gradual Likert scale (rarely, once or twice per month; sometimes, once or twice per week; frequently, three to five times per week; always, nearly every day). The subscales of “disorders of initiating and maintaining sleep,” “arousal disorders,” “disorders of the sleep–wake

transition,” “sleep-related breathing disorders,” “excessive sleepiness,” and “excessive sweating” allow a good overview of the most frequent sleep disorders. In healthy samples, the internal consistency is in a good area, whereas clinical samples are found in the satisfactory range. With a T value greater than 70, the score is considered as suspicious. The cutoff for the scales of “disorders of initiating and maintaining sleep” amounts to a raw value of 17, for “arousal disorders” to 7, for “sleep-related breathing disorders” to 14, and for “excessive sleepiness” to 13; a higher score corresponds to greater severity of the disorder.

11.1.6.4 Questionnaires for Self-Reporting

Children's Sleep Comic (CSC)

The children's sleep comic (CSC) is a tool for self-reporting and assesses sleeping habits and age-typical sleep problems in young children. The CSC was conceived for children between the ages of 5 and 10 years and was validated based on other tools such as the Children's Sleep Habits Questionnaire (CSHQ) and the Diagnostic Interview of Pediatric Sleep Disorders (DIKS, Diagnostisches Interview Kindlicher Schlafstörungen). The internal consistency is rather high. The comparison with respective diagnoses according to DIKS showed significant correlations. The children's sleep comic may be applied as a reliable tool for self-assessment as well as maintaining the contact to the child and his/her sleeping habits.

Sleep Self-Report (SSR)

The Sleep Self-Report (SSR) is a validated tool to assess pediatric sleep disorders from the child's perspective between the ages of 7 and 12 years. Because many items correspond to the version of the questionnaire for parents, a comparison between the answers of the parents and the children is possible. The cutoff is reached at 25 (sensitivity, 73%; specificity, 64%); a conspicuous stanine value of 8 is applicable as of a SSR total score of 31. However, to fill in the questionnaire, the child should be able to read and write.

Screening of Pediatric Sleep Disorders (PSS-J)

The screening of pediatric sleep disorders for adolescents (PSS-J) is a short screening tool for diagnosis of possible sleep problems in adolescence. The PSS-J consists of seven screening items with

detailed questions for better clarification of the respective problem area. Based on the criteria mentioned in the PSS-J, the diagnosis may very rapidly reveal the symptoms of a sleep disorder.

Epworth Sleepiness Scale for Children (ESS-C)

Originally, the Epworth Sleepiness Scale is a self-reporting scale validated for adults for monitoring daytime sleepiness (see ► Chap. 2). The ESS version for children and adolescents (ESS-C) has been adapted for the age group of 6- to 19-year-old individuals. It encompasses seven items. On a four-point scale with the gradation of 0 (I never drop off), 1 (I rarely drop off), 2 (I frequently drop off), and 3 (I nearly always drop off), the children and adolescents estimate their likelihood to fall asleep in the listed situations. A verification of the psychometric properties of the ESS-C is currently not available. The cutoff for adolescents (age group between 13 and 19 years) amounts to a sum score of 13 points. Higher values have to be considered as noteworthy.

Nightmares Effects Questionnaire (NEQ)

Nightmares in adolescence may sometimes have massive impacts on daytime alertness. The Nightmares Effects Questionnaire (NEQ) assesses the effects of nightmares on the daytime alertness of adolescents and adults. The NEQ includes more than 30 items to evaluate the daytime impairment, which is characterized by six factors: (1) emotion regulation, (2) stress and aggressiveness, (3) depression, (4) attentiveness/concentration, (5) anxiety, and (6) hyperactivity. The NEQ has high reliability and may be considered as an excellent tool for assessment of daytime impairments resulting from nightmares in adolescents and adults.

11.1.6.5 Interviews

Furthermore, several standardized interviews are available as comprehensive and very exact procedures:

Diagnostic Interview of Pediatric Sleep Disorders (DIKS)

Based on the criteria of the ICSD-3, the DSM-5, and the ICD-10, an interview was developed for sleep disorders in preschool children and schoolchildren between the ages of 5 and 10 years that is based on the parents' report. Based on the parents'

reports, discrimination is possible among the most frequent sleep disorders.

Sleep Inventory for Children and Adolescents (SI-KJ)

The sleep inventory for children and adolescents (SI-KJ) encompasses the age group of 5 to 10 years. Based on four different tools, detailed diagnostics of sleep problems and sleep disorders in children and adolescents are possible. The sleep inventory takes into account the child's own as well as the parental perspective.

Diagnostic Interview of Adolescent Sleep Disorders (DIAS)

The interview is also based on criteria of the ICSD-3, DSM-5, and ICD-10 and can be applied either from the self-reporting perspective or from the perspective of the parents. Therefore, it consists of two versions. The age relationship refers to adolescents between 11 and 21 years. Frequently observed sleep disorders are assessed and can be examined by differential diagnostics.

In general, the interviews have a high content validity.

For assessment of further effects such as behavioral problems, further instruments such as questionnaires on behavioral disorders in children and adolescents may be reasonable in addition to the application of sleep-specific tools to evaluate the daytime impairment or psychological problems. Besides the Child Behavior Checklist (CBCL) in the version for parents and the derived questionnaires for self-report of children/adolescents (YSR) and for teachers (TRF), also the Strengths and Difficulties Questionnaire (SDQ) as well as other tools may be applied.

11.1.6.6 Test Psychological Examinations

To differentiate a possible psychological or cognitive impairment, a test psychological examination (performed by psychologists, psychotherapists for children and adolescents, or psychiatrists for children and adolescents) may be recommended. Such an examination should be planned if hints are found of a cognitive or psychiatric disorder (e.g., anxiety disorder, ADHD). Comprehensive diagnostics are necessary because psychiatric diseases may be associated in particular with disorders of initiating and maintaining sleep and

nightmares, and sometimes also sleep-related breathing disorders. Intelligence tests (Wechsler Intelligence Scale for Children, WISC) as well as attentiveness tests (e.g., pediatric version of the test battery on attention, KiTAP; TAP for adolescents; and the d2 test of attention) may reveal daytime impairments as well as comorbid symptoms/disorders.

11.1.6.7 Physical Examination

To exclude physical origins for sleep problems of children and adolescents, a comprehensive physical examination is essential. In this context, possibly the melatonin level (in case of suspected sleep-wake rhythm disorders) or also the iron level (in case of suspected restless legs syndrome in childhood) should be measured (see also ► Chap. 2).

11.1.7 Sleep Medical Diagnostics

11.1.7.1 Actigraphy

An actigraph can be applied to measure physical activity and to identify disorders of the sleep-wake rhythm or movements during sleep (see ► Chap. 2). In infants, the actigraph is placed at the lower leg; older children wear the actigraph at the wrist. It may be useful to assess the sleep for several days to identify recurrent patterns. Attention must be paid that the evaluation software is specially developed for children because they move significantly more during sleep and thus produce other patterns. Evaluations performed by software designed for adults would result in erroneous sleep and wake times. However, for extensive sleep medical examination of children, inpatient polysomnography is also required.

11.1.7.2 Polysomnography

If a sleep-related breathing disorder is assumed, or any other rather organic sleep disorder, a pediatric sleep laboratory should be involved, and polysomnographic examination should be initiated. In particular in cases of suspected periodic leg movements during sleep/restless legs, epileptic seizures at night, narcolepsy, disorders of the sleep-wake rhythm, or chronic insomnia, in general examination in a sleep laboratory is recommended. For diagnosis of nonorganic insomnia as well as nightmare disorder or pavor nocturnus, PSG usually is not necessary.

The basics of performing and evaluating polysomnography are described in ► Chap. 2. In the context of childhood and adolescence, however, the following particularities have to be observed with regard to technical performance and the subsequent evaluation because polysomnography examinations of infants, children, and adolescents are clearly more difficult and should meet special requirements. Children are often much more irritated by the unfamiliar environment than adults so placing the necessary measuring instruments may be problematical. Therefore, a comfortable and friendly atmosphere should be created. The applied sensors have to be adapted to the children and their smaller body surface without disturbing them in their sleep behavior. Sometimes the electrodes have to be placed closer to each other (e.g., to assess leg movements). Technically, the application of high-resolution digitization parameters for assessing and displaying the measured signals is important for examinations in children because, in comparison to adults, children have a clearly higher breathing and heartbeat frequency. Furthermore, the EEG amplitudes are more variable in this young age group. The electrodes should be placed according to age. For 2-year-old children, the following structure is recommended because of the asynchronously occurring sleep spindles: F4-M1, C4-M1, O2-M1, F3-M2, C3-M2, O1-M2, C4-Cz, and C3-Cz (see also ► Sect. 2.6). However, the feasibility is essential for the measurement so that for routinely performed measurements possibly only C3-M2 and C4-M1 should be measured in children younger than 2 years to minimize the stress for these young patients. In addition, young children react strongly to the sensors for measuring oral and nasal breathing, so it is probably suitable to limit the measurements to the oronasal thermistor or nasal suction pressure. According to the recommendations of the American Academy of Sleep Medicine (AASM), the measurement of suction pressure should be preferred for the identification of hypopnea.

Because children might react strongly to unfamiliar environments, an examination during two nights is recommended. If after the first night clear results have already been obtained, assessment on a second night can be omitted.

Limb movements as well as an overall high movement frequency are typical for children. Phases with such movement artifacts lasting more than 15 s are a frequently observed phenomenon,

but they are not regularly associated with a transition to another sleep stage. In children with ADHD or with sleep-related breathing disorders, movements lasting more than 10 s are often observed and are typical for the disorder.

With regard to the evaluation of the breathing pattern, the child's age should be considered because the breathing frequency is modified depending on the development. According to the criteria of the AASM, at least two skipped breaths related to the previous breathing pattern allow the assumption of obstructive apnea if the amplitude of the oronasal airflow is reduced by 90% or more as well as a continuous or even increased effort is measured for breathing. However, only in children up to the age of 8 years is such a pattern observed relatively often in the context of movements. Therefore, the measurement of the leg EMG is essential for classification. If the symptoms occur during movement, they should not be considered.

11.1.8 Differential Diagnostics

As already mentioned, sleep complaints or disorders also frequently occur in other psychological or physical disorders. In those cases, it has to be determined if the sleep problems are the focus and have to be treated first, or if the sleep-related difficulties have to be considered in the context of other disorders. Then, the treatment of the underlying disease is indicated together with a referral to a pediatrician, a pediatric psychiatrist, or a pediatric psychotherapist. Hence, it is important that the sleep disorder is included in the therapy and to treat it appropriately.

The Child or Adolescent Should Be Referred to a Sleep Specialist

- In cases of chronified disorders of initiating and maintaining sleep
- If the child/adolescent is not restored when waking up in the morning over a longer time or if it is difficult to wake him/her up
- In cases of relevant daytime sleepiness (falling asleep at school, during trips in buses/cars/trains of less than half an hour)

- In cases of chronic snoring/breathing noise at night or breathing interruptions
- In cases of behavioral disorders at night that cannot be explained otherwise

11.1.9 Insomnia Therapy in Childhood

11.1.9.1 Sleep Education and Sleep Hygiene

Age-appropriate information and psycho-education is an important component of sleep medical counseling in childhood and adolescence. Information for parents but also for children regarding healthy sleep as well as the consequences of poor sleep quality are important. In particular, providing information about age-appropriate and age-based sleep duration is essential. Furthermore, information should be given about factors influencing sleep, for example, the parental behavior or media consumption, and the importance of a healthy and age-adequate sleep quality environment should be discussed. Often, this information also contains recommendations for good sleep hygiene to improve sleep quality and to achieve a higher sleep duration and efficiency. In this way, the daytime sleepiness of children and adolescents can also be reduced. It must also be taken into consideration that the recommendations regarding sleep hygiene should be adapted to the developmental stage and the cultural values of the children and adolescents as well as their families. The following examples represent age-oriented recommendations.

Sleep Hygiene Recommendations for Preschool Children

- Parents should take turns bringing their child to bed. In this way it can be avoided that going to sleep is associated to a certain person, which promotes the child's autonomy regarding the behavior of sleep onset.
- Daytime activity and physical activity of the day have an impact on the evening tiredness and sleepiness of the child. An active waking time with sufficient physical activity as well as mentally stimulating and creative playing contribute to restorative sleep. These activities, however, should not take place directly before going to sleep.

- Sleep-related self-soothing strategies of the child should be supported.
- When parents have put their child to bed, they should not hurry back and lift him/her up at the slightest noise. Waiting briefly may help the child to apply self-soothing strategies. Of course, it is important the parents let their children know that they are always there if he/she really needs them.

Sleep hygiene recommendations for schoolchildren:

- The parents' bed should only be available as a refuge in exceptional situations (for example, when the child is ill).
- It should be possible that the child perceives his/her room as shelter. The sleep environment should be designed according to the anxieties and preferences of the child if they have sleep-improving properties (calm, quiet, dark, etc.).
- At least 2 h before going to bed, watching TV and playing computer games should be discontinued. There must be enough time for the child to process the daytime noises and images. In this way, events that have happened during daytime can be discussed and may lose their probably stressing character.

Sleep hygiene recommendations for adolescents:

- Sun or light in the morning: allow the sun in the morning to shine into the room and to expose the room to as much daylight as possible; this helps getting awake and fit. At night, however, the room should be dark so that the body may relax and restorative sleep is possible.
- Avoid a clock at the bedside: removing the clock from the bedside so that the adolescent cannot read the time at night may be helpful in the context of unfavorable sleep-related cognitions.

11.1.9.2 Stimulus Control and Structured Bed Routine

Besides sleep education and sleep hygiene, stimulus control also belongs to the standard elements in the context of treating insomnias in children and adolescents.

The Following Aspects of Stimulus Control and Structured Bed Routine Are Relevant for Children and Adolescents

- **Sleeping area:** The bed should be used only for sleeping. Activities such as watching movies, listening to music, learning, doing homework, or using other media (e.g., smartphone, tablet) should not take place in bed and thus not be associated with sleep.
- **Time of going to bed:** The child or adolescent should go or be taken to bed when he/she is tired.
- **Initiating sleep:** Depending on the age, it is often recommended that the child or adolescent leave the bed after 15–20 min if not able to fall asleep. Alternatively, the child may apply relaxation techniques or other mental distraction strategies (see below).
- **Rhythm:** In the morning, the child or adolescent should get up if possible at the same time and in the evening go to bed at approximately the same time.
- **Daytime sleep:** Daytime sleep should be avoided as of a certain age (about 5 years); this is especially important for adolescents. Sleeping during daytime, too long and too late, may significantly impair night sleep and even support a rhythm shift. If day sleep is necessary, a nap should take place early in the afternoon and not exceed 20–30 min.

These recommendations of stimulus control and bed routine are effective, especially for parents of young children, and may significantly improve the sleep behavior.

11.1.9.3 Extinction

If a child opposes going to bed or wants to come into the parents' bed at night, the procedure of extinction may be suitable and effective. In this context, the parents learn to remain consequent and to effectively ignore the child's disturbing behavior. In case of disturbing behavior of the child (calling for the parents, leaving the bed and asking to be allowed to watch TV or sleep in the parents' bed), the parents do not react with fulfilling the wish. Hereby, it is important that the parents remain consistent until the child's behavior no longer occurs. This result is called extinction when there are no positive consequences con-

cerning problem behavior. Regarding implementation, however, it must be ensured that the parents are confident with this method and that they are certain that their child is not afraid.

11.1.9.4 Positive Reinforcement

A very effective strategy to modify a child's behavior is positive reinforcement. The child is offered an attractive reward for showing a certain desired behavior. For example, the child could receive a small gift in the morning, deposited by the sleep fairy, if he/she has stayed in bed in the evening or has tolerated being brought to bed alternatively by the parents (the mother in one evening, the father in the other evening). The reward, however, can also be immaterial (for example, having special time exclusively with the father). In this context, the difference must be made between short-term reinforcement (direct) or long-term reinforcement (for example, after 1 week or 1 month). In this way, a long-term reward may be agreed on for successfully modified behavior. In particular for young children, however, short-term reinforcement strategies should be applied because their time perception is different from that of older children or adults. Adolescents, however, may well anticipate long-term reinforcement.

11.1.9.5 Relaxation Techniques

In children and adolescents, relaxation techniques may also be applied. It must be noted here that progressive muscle relaxation (PMR) is easy for children and adolescents to learn compared to autogenic training. Techniques that are related to this procedure, such as imaginative techniques or relaxation training are also suitable for children and adolescents as of a certain age. Regarding the implementation, care should be taken for an age-appropriate application. The general rule to be applied is the older the child the more complex techniques can be learned and implemented. Younger children need simpler and easier strategies. In younger children of preschool age, massage techniques and physical relaxation strategies, for example, caressing the back, may contribute to the child's relaxation and encourage sleep. Also, relaxing by singing a song to the child or repeating rhymes as more speech-oriented options may be helpful for some children. Parents should try different strategies to decide which is best suited for their child.

11.1.9.6 Cognitive Restructuring

Concerns, impairing cognitions, and irrational convictions may also develop in children and adolescents with sleep disorders at a certain age (mostly at the beginning of school age). Therefore, the procedure of cognitive restructuring may be applied in an age-appropriate way in cognitive behavioral therapy (CBT). Those unfavorable sleep-related cognitions may increase arousal in children or adolescents and thus contribute to the stability and chronification of sleep problems.

Also in childhood and adolescence, different sleep-related cognitions may be differentiated:

- Unfavorable cognitions about the origins of insomnia: "Mum and Dad have to be by my side otherwise I cannot fall asleep."
- Unfavorable cognitions regarding sleep-encouraging strategies: "I can better fall asleep when I am online in bed and have my smartphone with me."
- Wrong associations regarding the consequences of poor sleep: "If I do not sleep well this night, I will not be able to provide good performances and I will fail in school."
- Unrealistic expectations toward sleep: "I have to sleep well every night, otherwise I will get ill."

11.1.9.7 Imaginative Techniques/ Modern Hypnotherapy

Generally, children and adolescents benefit from pictorial and imaginative techniques. A modification of sleep is possible with such procedures. Hypnotherapeutic treatment of children and adolescents suffering from sleep disorders shows first results based on reports of single cases. Also, imaginary rescripting therapy (IRT) that is applied for treatment of nightmare disorders is included in the group of imaginative therapy approaches (see ► Chap. 7). The implementation of this technique in age-appropriate ways shows very good results in the treatment of nightmares. The therapy of PTSD is based on the same procedure.

11.1.9.8 Bedtime Restriction

For children and adolescents who spend too much time in their bed when not using it for sleeping, bedtime restriction may be suitable. First, the time in bed is reduced to real sleep

duration the child or adolescent. The aforementioned sleep diary may serve as the basis for the calculation of the actual sleeping time. After 1 week, the sleep efficiency is calculated (see ► Chap. 2). Based on the number of hours, the sleep duration is gradually increased if the sleep efficiency amounts to 85% to 90%. Then, the time of going to bed is gradually advanced in the following weeks until the desired sleep duration is reached. The positive outcome of such a procedure is confirmed for cases of insomnia in particular for adults (see ► Chap. 3). However, regarding the treatment of children and adolescents, results are still possible.

11.1.9.9 Age-Oriented Interventions

In the following, age-appropriate structured treatment programs are presented, which, according to age, are focused on parents, involve parents and children, or mainly concentrate on adolescents. These three age-oriented treatment programs are predominantly based on cognitive behavioral therapy with insomnia (CBT-I) and imaginative/hypnotherapeutic techniques. The aforementioned techniques (rules of sleep hygiene, relaxation procedures, stimulus control, extinction, or other therapeutic procedures) are generally included.

Not all these procedures are suitable for each age. The younger a child is, the more the parents have to be included and involved in the treatment. Different sleep problems or disorders occurring simultaneously as comorbidities have to be taken into consideration. In this way, a child may suffer from problems of insomnia and at the same time from a sleep-related breathing disorder. Therefore, adequate diagnostics and a structured procedure are essential.

11.1.9.10 Treatment of Infants and Children of Preschool Age

For young children, the aforementioned methods of behavioral modifications such as stimulus control, sleep education, and extinction or restructuring are especially effective approaches. Based on the following case report, symptoms are described that are typical for early childhood. It will become clear that the parents have to be involved in the intervention.

Case Report

A 3-year-old boy called Paul lives together with his younger sister (age 2 years) and both parents in the parental household. Both parents work during the day. They report that Paul has always had rather poor sleep. His birth was highly complicated and they had enormous concern for his health. Several weeks were needed after his birth before they could take him home. They always stayed with him until he had fallen asleep because they were afraid of missing some concern about their child. Thus, he was used to always having his mother or father around him in the evening. By and by, he increasingly required his mother to be present in the evening and meanwhile refuses his father when the father tries to bring him to bed or wants to calm him at night. Each attempt to change the situation is refused by Paul, and he starts screaming and crying until his mother is there.

This case report makes clear that the sleep problems often start with an early disruption or an event. Based on the subsequent educational behavior of the parents regarding sleep, Paul developed a preference, and it is no longer the act of sleeping itself, but he chooses his mother and decides that only she “is allowed” to help him. Hereby the educational problem becomes obvious. If Paul was really afraid, he would also accept his father’s presence and would cooperate. The fact that he refuses being consoled by him shows that he wants to influence his parents by applying this behavioral pattern. In the context of such problems, the parents should communicate the altered roles, visualize them, and ignore Paul’s moaning and complaining (see further aspects under “Mini-KiSS”).

In the context of treating such sleep problems, parents might design a positive *sleep environment* for Paul and modify the evening *bedtime ritual* in a way that it is new for Paul and interesting without stimulating him too much. By means of, for example, photos placed at the door that describe the procedure of going to bed and which the parents have already talked about with Paul during the day, Paul is already prepared for going to bed in another way. Based on the possibility of *extinction*, parents may change their behavior starting at this point. In the photos, the parents have the security of visual

support. However, it is important that the parents reflect their previous, unconsciously reinforcing behavior (*cognitive restructuring*). The parents should also apply *positive reinforcement* (sleep fairy in the morning; see mini-KiSS) so that the probability for a change in Paul's behavior increases.

Mini-KiSS Training: Treating Early Childhood Sleep Disorders

Taking into account the aforementioned basics of age-adapted therapy in early childhood, the so-called Mini-KiSS program has been developed and comprehensively evaluated. Based on the structured and manualized procedure, the therapist/physician has good options to treat typical age-oriented problems within six sessions. The age-appropriate treatment program focuses on insomnias, sleep-related anxieties, resistance when going to bed, and nightmares. It is based on training elements such as psycho-education, sleep hygiene, sleep-related educational competences, learning relaxation techniques by parents and

child, learning appropriate sleep-related strategies of resolving problems of parents and child, and reduction of dysfunctional, sleep-related as well as general cognition of parents on the basis of CBT-I techniques. To ensure the integration into daily routine, parents receive exercises after each session for training. For physicians/therapists, a comprehensive trainer manual and the respective material for parents are available. ■ Table 11.1 briefly describes the single sessions and thus allows an overview.

This sleep training includes all relevant topics for treatment of typical and frequently occurring sleep disorders in early childhood, in particular, regarding disorders of initiating and maintaining sleep, nightmares, and sleep-related anxieties.

Such a procedure is well accepted by parents, and according to several studies, it leads to a reduction of sleep problems as well as the improved psychological well-being of the children. Parents also benefit from the training with regard to their own sleep and their psychological situation.

■ Table 11.1 Overview about the Mini-KiSS training

Session and purpose		Contents
1	Psycho-education	Introduction, information about sleep: day–night rhythm, function of sleep, sleep disorders, influencing factors regarding sleep, rituals, daily structure, etc., exercises to do at home
2	Thorough checkup of situations and sleep behavior	Correlation of sleep and behavior during the day, vicious cycle of sleep pressure, educational behavior and child's sleep, educational rules for healthy sleep, house of healthy sleep, educational strategies, creative resolution of problems, Kalimba the sleep helper, exercises to do at home
3	Crying, screaming, and stubbornness	Crying and screaming, soothing techniques, stubbornness and childhood aggression, behavioral recommendations, alteration of the sleeping place environment, exercises to do at home
4	Stress and relaxation	Stress and relaxation, escalation trap, stress enhancing factors, mental control techniques, time and attention for the child, time for oneself, imagination exercises, exercises to do at home
5	Anxiety and security	Security and childhood anxieties, help in case of nighttime fears, help for nightmares, stepwise procedure in problem situations, modification of sleep and nutrition, relaxation and massage techniques for the child, imagination exercises, exercises to do at home
6	Concluding session	Temptation to indulge: typical traps regarding sleep behavior, sleep habits, feedback, exercises to do at home

11.1.9.11 Treatment of Schoolchildren

Schoolchildren are cognitively more able to think and worry. Also, anxieties occur frequently at that age. Based on the following case report, typical symptoms are described as well as the procedure in the context of schoolchildren.

Case Report

The 8-year-old Sophie is presented with insomnia symptoms. Her parents report that she frequently needs more than 1 h to fall asleep. Sophie is the oldest of three children; her younger sister Clara shares the bedroom with her, and the youngest sister Marla (4 years) still sleeps in the parents' bedroom. Sophie appears to be thoughtful and very considerate toward her younger sister, who suffers from asthma. She provides toys and entertains her sister during waiting times. In the further course, it becomes obvious that Sophie is highly concerned about her sister's health because Clara has already had to go to hospital several times because of her breathing problems. During KiSS training (see following), it became apparent that Sophie was afraid of falling asleep because her sister presents breathing problems at times. Sophie does not know if she will be woken up at night by her sister's problem, and so she gradually developed the fear of falling asleep. Furthermore, she meanwhile dreams of falling and of monsters, which also cause anxiety.

For the treatment of Sophie, different procedures may be suitable. On one hand, Sophie should have a positive *sleep environment* giving her the feeling of safety and courage. The parents may, for example, change her sleep environment with positive elements taken from Sophie's preferred stories or fairy tales. Further, she should learn to *relax* (PMR, magic breath; see KiSS) so that she does not focus on her concerns in the evening but on relaxing her body. A cuddly toy as sleep helper, together with *imagination techniques* and respective bedtime stories, may work as a coping model (see KiSS) as well as being comforting and encouraging for the child. The evenings should be spent in a way that Sophie is able to better cope with the worries and concerns of the day. For this purpose, creative *methods of CBT-I* for children may be helpful (e.g., sorrow box). The evening *bedtime ritual* can be associated with encouraging slogans (CBT-I for children) so that Sophie is in a positive

mood and likes going to bed. The parents should further apply positive reinforcements so that Sophie is rewarded when she succeeds in sleeping well and is motivated to implement the strategies she has learned.

For children of Sophie's age – between 5 and 10 years – the sleep training for children was developed as is described in the following. Also here, comprehensive systematic verifications regarding the effectiveness of the therapeutic scheme have been performed so that also KiSS training is displayed as an example for a treatment program for schoolchildren.

KiSS Training: Treating Sleep Disorders in Schoolchildren

KiSS training addresses children between 5 and 10 years of age suffering from insomnia or nightmares. This treatment program also encompasses six sessions for children with sleep difficulties and disorders and is based on the aforementioned techniques (CBT-I and imaginative elements or hypnotherapeutic implications). The treatment program includes three sessions with the children and three sessions with parents: the contents of the sessions are summarized in [Table 11.2](#). The central element in the children's sessions is the soft toy *Kalimba*, a stuffed leopard, that fulfills several functions: as a model, it is intended to associate properties such as strength, courage, speed, and fearlessness. Furthermore, it is company and an object of protection for the children to feel supported; and finally it serves as a memory keeper for the strategies that have been learned so that the children may easily recall the lessons although they often cannot read or write.

The children's sessions are designed age-appropriately by *Kalimba*. Folders with drawings of *Kalimba* support active cooperation during the sessions and serve as memory keepers for exercises to do at home. In this context it must be emphasized that there is no need for children to be able to read or write to memorize strategies and to implement or recall them later. Also, this training includes parents' sessions with psycho-educative elements as well as sleep-related educational situations. In this age group, the focus is placed more on the topic of fears and sorrows because in school age thoughtfulness and concerns may have a sleep-impairing role and thus impede the restorative and sufficient sleep of the child.

Table 11.2 Overview of the KiSS training

Session and purpose		Contents
1	Parents' session 1: psycho-education	Information about the development of sleep disorders (psycho-education); behavioral recommendations, educational strategies for healthy sleep behavior
2	Child's session 1: sleep behavior from the child's perspective	Information about healthy sleep; rules of sleep hygiene; introduction of Kalimba, magic breathing as relaxation technique
3	Parents' session 2: sleep situations	Modifying specific sleep situations, sleep rules, activating resources for resolving problems
4	Child's session 2: modifying sleep behavior	Modifying of sleep-specific behavioral patterns, using Kalimba to cope with fears of sleep
5	Child's session 3: fears and sorrows	Overcoming sleep problems with Kalimba, coping with sorrows and thoughtfulness, learning review
6	Parents' session 3: transfer	Training of the learned strategies, going into detail of specific difficult sleep situations

Also regarding the KiSS-intervention, several studies show a high satisfaction as well as a significant reduction of sleep-related symptoms up to 1 year. Furthermore, the psychological well-being of the children may be improved.

11.1.9.12 Treatment of Adolescents

In adolescence, parents have a relatively less important role regarding sleep than in other age groups, but the changes of puberty, which are also changes sleep and the psychological shifts must be taken into consideration. Furthermore, media have a more and more important role. The following case report tries to demonstrate this phenomenon.

Case Report

The 15-year-old Marius presents to the sleep medical center. He reports that he has often difficulties calming down in the evening and needs quite a long time to fall asleep. He then often switches on the computer to play, increasingly even at night. Then he forgets about the time, but at least it distracts him. Just lying down, he sees his desk and immediately the next exams come to his mind. This stresses him because he could have bad results. Further, he does not get along with his teacher. And altogether, he does not like school at all! In the morning, he has difficulties

getting up; he often feels absolutely whacked, and sometimes he is not even able to get up and thus misses school. Of course, the consequences are visible. He has concentration problems and worries that he cannot be promoted because of bad marks. He notices himself that he is mentally distracted and cannot focus. Also, the parents report that he is very tense and aggressive in the afternoon, which has a strong impact on the family life. He sleeps poorly and is afraid of getting addicted to gambling.

This description makes clear that Marius already has many symptoms of insomnia as it is seen in adults (see ► Chap. 2). He often worries in the evening, thinks about the consequences of his sleep problems, and fears sequelae regarding school performance and health. It is obvious that Marius has a typical teen bedroom with his bed, desk, and media, which can sometimes impair good sleep.

In the case of Marius, different aspects have to be taken into consideration. Besides comprehensive and differential diagnostic examination of non-substance-related addiction problems, however, clearly the school-based stress is also the focus. Therefore, the treatment should include an adaptation of the *sleep environment* so that Marius is not confronted with the topic of school in the

Table 11.3 Overview of JuSt training

Session and purpose		Contents
1	Adolescent session 1: psycho-education	Prof. Paul Paulsen as “Sleep Doc,” sleep lab, rules and rewarding system, development of sleep disorders (psycho-education), imagination exercises
2	Adolescent session 2: sleep hygiene	Discussion of the exercises, rules of sleep hygiene
3	Parents’ session: sleep and parental behavior	Sleep and sleep disorders, consequences of sleep problems, parents’ educational behavior and sleep of the adolescent, comfortable sleep environment
4	Adolescent session 3: sleep environment	Stimulus control, sleep rituals, rules of sleep hygiene, imagination exercises
5	Adolescent session 4: fears and sorrows	Dealing with sorrows and thoughtfulness, restructuring of sleep-impairing cognitions, imagination exercises
6	Adolescent session 5: stress	Sleep and stress, techniques for stress reduction, imagination exercises, my private sleep lab, sleep quiz: “Who wants to be a sleeponaire?”

evening. Furthermore, general relaxation techniques should be taught (PMR); it may also be helpful to apply *imaginative procedures* for cognitive relaxation. By means of *cognitive procedures* in the context of insomnia (CBT-I), sleep-impairing thoughts may be identified and modified accordingly. Marius should also imperatively work on *rules of sleep hygiene* with the goal that he no longer plays computer games in the evening or at night. His depressive mood may be treated with the options of *positive psychology*.

JuSt Training: Sleep Training of Adolescents

In analogy to the KiSS training for younger children, the JuSt training here is presented as sleep training for adolescents. Teens already show significantly more sleep-related cognitions so that the treatment of adolescents with insomnia or nightmares is rather similar to that of adults with the respective CBT-I strategies (see ► Chap. 2). However, in this training further sleep problems such as sleep-wake rhythm disorders and puberty-related imbalances of the chronotype are focused. It must also be taken into consideration that the strategies elaborated for adults cannot be fully applied in this age group.

Regarding their adolescent children, parents often do not know much about the puberty- and sleep-related changes and the necessary sleep duration (in particular, sleep duration of adolescents amounting to about 9 h; see earlier). In this age group, the parents no longer have a crucial role at bedtime because teenagers mostly go to bed on their own. Also, the treatment program of adolescents encompasses six sessions, but because of the aforementioned aspects, five sessions are conducted for adolescents. During the training, the adolescents meet “Sleep-Doc Prof. Paul Paulsen” in a fictional sleep lab who presents the appropriate strategy for the adolescent (see ■ Table 11.3).

Also the JuSt is well accepted by adolescents and their parents; after the training significant improvements of the sleep problems are seen. The problems of initiating and maintaining sleep are significantly reduced, and sleep efficiency as well as the overall sleep duration can be increased. In addition, the adolescents report a significantly less important tendency to worrying after the training and are less focused on their sleep problems. Even after 3 months to as long as 1 year, these significant results remain stable, and so a long-term effectiveness may be assumed.

11.1.10 Therapy of Other Pediatric Sleep Disorders

11.1.10.1 Treatment of Delayed Sleep Phase Syndrome

The treatment may be performed by means of so-called chronotherapy. This therapy includes a successive delaying of going to bed by 2 to 3 h per day until an adequate time of sleep onset is reached. This bedtime should be consequently observed. If an adolescent goes to bed at 3 o'clock at night, for example, the timepoint of going to bed should be gradually delayed until the adolescent goes to bed at an adequate time. This procedure takes some days, but the effect is that a certain rhythm is achieved. In this way, a possibly existing absence from school may be eliminated, and a resumption of regular school visits can be started. In the concept of JuSt training, elements to modify the delayed sleep phase syndrome are found (session 3). Regularity of bedtime is an important objective of the treatment and should be emphasized for the adolescents. Hereby, the assessment of the evening activities (e.g., computer games) may be helpful for the identification of possible origins of the delay. Also the application of light therapy with 10,000 lux for 45 min in the morning is recommended by some authors, mostly applied in the inpatient situation. This measure is recommended in particular with the background of comorbid depressive disorders.

11.1.10.2 Treatment of the Advanced Sleep Phase Syndrome

Generally, patients report relevant tiredness in the early evening hours and waking up very early in the morning. This disorder is much rarer in children and adolescents compared to the delayed sleep phase syndrome. The treatment of the advanced sleep phase syndrome should be performed in the opposite direction. Chronotherapy is oriented at the subjective sleep time. Every day, the adolescent should go to bed 2 to 3 h earlier until an adequate timepoint of sleep onset is achieved. Also, this type of therapy has to be planned accurately. It is often performed in a partly or completely inpatient setting because of a frequently existing comorbidity. As already described, several studies show that exposure to light may also be helpful for adolescents with

chronotype-oriented symptoms. Application of light in the evening is considered to be effective in cases of advanced sleep phase syndrome. The application of light allows tiredness and sleepiness to start later so that the adolescents go to bed at a later time.

11.1.11 Drug Therapy

The administration of hypnotics leads to short-term improvement of the symptoms, in particular in cases of insomnia disorders; however, in the long term, behavioral therapeutic interventions seem to be superior. Thus, similar strategies apply for children and adolescents as for adults: for insomnia complaints and nightmares, psychotherapeutic procedures, generally based on the aforementioned techniques, are the measure of choice. For adolescents it must be observed that sleep-inducing drugs and hypnotics are applied only with permanent medical supervision.

The administration of melatonin may lead to a significant reduction of the duration of sleep onset, a prolongation of sleep duration, and an improvement of the quality of sleep. In previous trials, melatonin was well tolerated and did not cause severe side effects. Also, in children with ADHD and chronic problems of initiating sleep, different studies showed that the application of melatonin led to a reduction of the latency of initiating sleep and an increased duration of night sleep after an intake during about 4 weeks. Drug therapy with sleep-inducing homeopathic preparations may be started, only after careful decision. This rule is often neglected, and medication is taken because other options are not available. If the therapy with homeopathic drugs is not successful, sleep-triggering non-hypnotics such as low-potent neuroleptics may be prescribed, and only if even this therapy does not have a positive effect, hypnotics may be taken.

11.1.12 Rehabilitation Measures

In cases of high chronification and family impairment or impaired implementation of the sleep medical recommendations by the parents, rehabilitation measures may be suitable.

Practical Tip

Possible indications of sleep medicine regarding pediatric rehabilitation might be, for example:

- Chronic insomnias without CBT-treatment improvements
- Sleep-related breathing disorders
- Sleep-related hypoventilation syndromes
- Sleep disorders caused by other diseases (psychological disorders, chronic organic disorders)
- Hypersomnias, for example, narcolepsy
- Sleep–wake rhythm disorders
- Parasomnias
- Nocturnal movement disorders

Possible objectives of such rehabilitation strategies might be:

- Improvement of sleep hygiene by modifying the context
- Including the family and implementation of sleep-related measures on an inpatient basis
- In cases of sleep–wake rhythm disorders: measures of behavioral therapy for finding a day and night rhythm with specific support
- In cases of sleep-related breathing disorders, possible introduction of weight reduction and nutritional advice
- In cases of comorbid disorders: reduction of comorbidities for improvement of the somatic and psychiatric risk profile
- Improvement or restoration of the limited participation ability and restoration of the psychological balance such as the renewal of the ability to go to school for adolescents

11.2 Sleep-Related Breathing Disorders in Children

In correspondence to sleep-related breathing disorders in adults, sleep-related breathing disorders with and without obstruction of the upper airways are also found in children and they are substantially different with regard to their pathophysiology as well as diagnosis and treatment. The most important sleep-related breathing disorders in children that are discussed here are summarized in [Table 11.4](#).

Table 11.4 Most important sleep-related breathing disorders in children and their incidence (as far as it is known)

Sleep-related breathing disorder	Incidence
Congenital central alveolar hypoventilation syndrome	Very rare ^a
Sleep apnea in infants	
Secondary sleep-related hypoventilation	
Pediatric snoring	4–8 (10–21)% ^b
Pediatric obstructive sleep apnea	1–4%

^aApproximately 1:200,000 live births

^bPermanent (occasional) snoring (according to parents' report)

11.2.1 Nonobstructive Sleep-Related Breathing Disorders

11.2.1.1 Congenital Central Alveolar Hypoventilation Syndrome

The congenital central alveolar hypoventilation syndrome or Undine's curse syndrome is a congenital disease that is caused by a disorder of the autonomous central breathing regulation. It is the result of a mutation of the PHOX2B gene, which is also mentioned as an obligatory diagnostic criterion in the ICSD-3. In case of good genotype-phenotype correlation, the number of polyalanine repeat mutations determines the severity of the disease. Because of negligible or completely missing central sensibility toward hypercapnia or hypoxia, severely affected children experience increasing hypoventilation and hypoxia during wakefulness; in even all affected children, it is observed during sleep. Also during wakefulness, these children show no respiratory response to hypercapnia, but in wakefulness they are able to control their breathing consciously. Also, in cases of combined hypercapnia and hypoxia, almost no arousal reactions are observed during sleep.

The congenital central alveolar hypoventilation syndrome occurs very rarely; an incidence of about 1 in 200,000 live births is assumed. The following possible origins of the breathing disorder have to be excluded before the diagnosis can be made:

- Neuromuscular diseases
- Pulmonary diseases

- Cardiac diseases
- Metabolic diseases
- Brainstem lesions

Children with congenital central alveolar hypoventilation syndrome become suspect as newborns with cyanosis and hypoxia and have to undergo postpartum intubation. In rare cases, so-called late-onset congenital central alveolar hypoventilation syndrome, the typical symptoms occur with delay in the course of further childhood development. With attempted weaning from the respirator, extended phases of hypoventilation occur, with hypercapnia and hypoxia.

Nearly all patients need lifelong ventilation therapy. In the course of further development, breathing becomes more stable in some children, at least during wakefulness, so that treatment is only required during sleep. The treatment consists of invasive ventilation via a tracheostoma or non-invasive ventilation therapy. Alternatively, a diaphragmatic pacemaker may be discussed for stimulation of the phrenic nerve at a later time. The children should be diagnosed and treated in a specialized institution. By means of appropriate therapy, these children may reach adult age.

11.2.1.2 Primary Sleep Apnea of Infancy

In early infancy, a series of phenomena are found that are explained by the immature condition of the infantine respiratory center. From the sleep medical point of view, the two most important ones are these:

- Primary sleep apnea of prematurity
- Primary sleep apnea of infancy

Apparent life-threatening events (ALTE) may appear in the context of those breathing disorders; however, their origins may be manifold. Apparent life-threatening events have several aspects in common with sudden infant death syndrome. The risk factors, however, are significantly different, so currently they have to be regarded as two distinct phenomena. The diagnosis and treatment of these phenomena is a primary responsibility of neonatologists and pediatricians.

The respiratory events in the context of the above mentioned sleep-related breathing disorders may be central, mixed, or also obstructive; however, the central genesis is typical. Regarding the definition of respiratory events, certain par-

ticularities have to be observed as they are explained more in detail in the section on obstructive sleep apnea in children (see ► Sect. 11.2.2). In this context, in particular the time-related criteria of apnea or hypopnea in children must be mentioned that are seen in relation to two previous breathing cycles of normal respiration.

The incidence of central breathing disorders in premature babies and newborns is directly dependent on the age of gestation. These disorders can mostly (but not only) be registered during sleep. Numerous external influences may trigger the occurrence of apnea. The breathing disorder ceases with maturation of the respiratory center; only in rare cases, for example, an intervention with pharmaceuticals is required.

Infant apnea manifests in the first 2 years of life. Also in this field, a correlation with the incomplete maturation of the central nervous respiratory regulation is assumed. Furthermore, a gastrointestinal reflux is correlated with the occurrence of apnea. Infant apnea often remains asymptomatic, but it may also lead to apparent life-threatening events. In this context, a series of differential diagnoses have to be observed, in particular infections of the airways and congenital syndromes (e.g., Arnold-Chiari malformation, Prader-Willi syndrome), but also syncope, breath-holding spells, convulsions, or diseases of the central nervous system.

11.2.1.3 Sleep-Related Hypoventilation Syndrome

Some types of sleep-related hypoventilation syndromes in adults may manifest in children in a comparable way. In cases of secondary sleep-related hypoventilation syndrome, hypoventilation becomes obvious because of the lower respiratory drive and the decreasing muscle tone during sleep. Underlying diseases include the following:

- Obstructive and nonobstructive pulmonary diseases (e.g., chronic bronchitis, bronchial asthma)
- Neuromuscular and vascular diseases
- Central nervous diseases (e.g., epilepsy)
- Morbid obesity

Diseases that manifest typically in childhood and that in the further course may lead to secondary sleep-related hypoventilation include the following:

- Cystic fibrosis/mucoviscidosis
- Neuromuscular diseases such as Duchenne muscular dystrophy

Obesity hypoventilation syndrome in childhood is rare; however, it is possible in adolescence and early adulthood. Similar to the findings in adults, the pathophysiological mechanism consists of a reduction of the thoracic and abdominal respiratory excursion caused by obesity. Additionally, obstructive sleep-related breathing disorder may be observed that is often caused by an obstructive component from adeno-tonsillar hyperplasia besides the obesity-based obstruction of the upper airways observed in these children.

The diagnostics of sleep-related hypoventilation syndromes in children are comparable to those of adult patients.

Also in children, the treatment should be based on the therapy of the underlying disease. If it is not or only insufficiently possible to treat the underlying disease, ventilation therapy at night may be required, probably also timely limited or intermittent, that might be performed as noninvasive CPAP ventilation or with bilevel devices. In cases of advanced neuromuscular diseases, often tracheostomy may be necessary in the further course for (initially nocturnal) ventilation therapy. Alternatively, also the nighttime application of oxygen may be discussed in the context of nonobstructive pulmonary diseases. The basics of ventilation therapy are comparable to those of adult patients. Particularities with regard to ventilation therapy in children are described in more detail in the following part of this chapter (see ► Sect. 11.2.2). The treatment of pediatric sleep-related breathing disorders should be imperatively performed in close cooperation with the institutions that are treating the underlying disease.

11.2.2 Obstructive Sleep-Related Breathing Disorders

In this context, the ICSD-3 mentions only *pediatric obstructive sleep apnea*. Snoring in children is not explicitly listed, but it is found, as is also snoring of adults, in its own paragraph on isolated symptoms and normal variants in the chapter of sleep-related breathing disorders.

The transition between these two phenomena, however, is fluid, and the determination is not always reliable in clinical routine; but there is often no imperative necessity for clear definition.

Furthermore, relevant overlapping is seen especially in the context of (surgical) therapy. Thus, both phenomena are described together in this chapter.

11.2.2.1 Definitions

A clear definition of pediatric snoring does not exist. From a practical point of view, pediatric snoring is diagnosed in general when relevant respiratory noise is reported by parents or guardians, and further examination (history and polysomnography) does not reveal any hint for pediatric obstructive sleep apnea. The definition of pediatric obstructive sleep apnea is based on the patient's history and polysomnographic criteria.

Diagnostic Criteria of Pediatric Obstructive Sleep Apnea According to the AASM

- Presence of at least one of the following symptoms:
 - Snoring
 - Strained, paradox, or obstructive breathing during sleep
 - Sleepiness, hyperactivity, behavioral problems, or learning difficulties
- The polysomnographic monitoring reveals one or both of the following particularities:
 - One or more obstructive apnea phases, mixed apnea, or hypopnea per hour of sleep
 - Signs of obstructive hypoventilation, defined as hypercapnia ($\text{PaCO}_2 > 50$ mmHg) during at least 25% of the total sleep duration in combination with at least one of the following phenomena:
 - Snoring
 - Flattening of the inspiratory nasal pressure graph
 - Paradoxical thoracoabdominal movements

As already mentioned, pediatric snoring may occur episodically and first manifest or increase/ aggravate in particular in the context of an acute infection. In clinical routine, the persistence of the complaints over a certain period of time, for example, during 4 weeks, has to be confirmed. In

its international classification of sleep disorders, however, the AASM does not include such a time criterion.

It can be easily seen that the definition is highly complex, and the diagnosis of pediatric obstructive sleep apnea according to the criteria presupposes a polysomnographic examination. However, in most healthcare systems, comprehensive polysomnographic examination of all children suffering from snoring or all children with suspected pediatric obstructive sleep apnea is not possible. With this background, it was implemented, for example, in German-speaking countries to confirm the indication of therapeutic measures in snoring children primarily based on medical history, clinical examination and questionnaires and to request previous polysomnographic diagnostics only when the children belong to defined risk groups.

11.2.2.2 Etiology and Pathophysiology

Corresponding to the obstructive sleep-related breathing disorders in adults, in pediatric patients suffering from obstructive sleep-related breathing disorders an increased resistance of the upper airway is also observed, with consecutive respiratory strain and sometimes reduction of airflow. The pathophysiological explanation models in this context mostly correspond to those of adults (see ► Chap. 4). Also, in this way, hypotonia of the upper airway dilating muscles during sleep finally induces the nocturnal breathing disorder.

Although in adults functional aspects have a major role, the anatomical factors leading to mechanical obstruction of the airway, such as *congenital malformations* or *syndromic diseases*, are predominant in children.

Malformations such as micrognathia, retrognathia, or midface hypoplasia are often associated with obstructive sleep apnea in children.

Furthermore, obstructive breathing disorders at nighttime are often observed in children with trisomy 21, which can be explained by the macroglossia and the frequently accompanying obesity. More rare syndromes are, for example, Pierre Robin sequence, Crouzon syndrome and Apert syndrome, Goldenhar syndrome, or achondroplasia, which are associated among others with malformations of the mandible and often with severe obstructions of the upper airway. Of course, hyperplasia of the lymphatic tis-

sue in all these children, as is physiologically observed in this age group, may contribute to deterioration or manifestation of the nighttime breathing disorder.

The predominant significance of *adenotonsillar hyperplasia* in the pathophysiology of pediatric obstructive sleep apnea becomes evident with the incidental association between adenotonsillar hyperplasia and sleep-related breathing disorder in children and the high effectiveness of surgical removal or reduction of the mentioned structures. Furthermore, numerous studies with imaging procedures revealed that the primary location of obstruction in children is generally found in the area of the pharyngeal or palatine tonsils, mainly where these structures overlap. In many studies, an increase of the mentioned lymphatic structures correlated not only with the occurrence but also with the severity of the sleep-related breathing disorder.

First of all, adenotonsillar hyperplasia in children is a physiological reaction and not pathological per se. Depending on the severity of the hyperplasia of the pharyngeal and palatine tonsils, symptoms may be completely missing or manifest only in the context of aggravating factors such as infection of the upper airway. On the other hand, such hyperplasia of the mentioned lymphatic organs may lead to massive obstructive sleep apnea. Also in this case, anatomical variants or comorbid disorders such as concomitant obesity may deteriorate the disease or favor its manifestation.

Unfortunately, obesity is increasing, even in children. Similar to observations in adults, obesity leads to fat deposits in the parapharyngeal soft tissue and thus to stenosis of the upper airway. In the future, an increasing number of sleep-related breathing disorders in children may be expected.

Practical Tip

Enlarged palatine and pharyngeal tonsils are the most important origin of pediatric obstructive sleep apnea. Often pediatric obesity is an aggravating factor, with increasing incidence.

Based on the described pathophysiological aspects, some authors request a classification of pediatric obstructive sleep apnea into three types:

- In *type I*, the adeno-tonsillar hyperplasia is in the focus.
- Pediatric obesity is predominant in *type II*, with less severe hyperplasia of the lymphatic system.
- Children with complex craniofacial or neuromuscular malformations are classified as *type III*.

From a didactical point of view, this classification seems to be reasonable; however, in practice it could not prevail.

Further factors contributing to sleep-related breathing disorder in children are *neuromuscular diseases* that may aggravate the hypotension of the pharyngeal dilators observed during sleep and *laryngopharyngeal reflux* that may enhance the airway obstruction via reflux-induced swelling of the mucosa.

In rare cases, surgical corrections of the palate as necessary for the treatment of cleft palates may contribute to postoperative occurrence or aggravation of nocturnal airway obstruction. Also, children suffering from laryngomalacia may present with primary or accompanying sleep-related breathing disorders.

11.2.2.3 Epidemiology

Snoring at night is widely observed in children. A recent epidemiological survey revealed that the incidence of permanent snoring in children reported by their parents amounts to 4% to 8% depending on the age, whereas the prevalence for occasional snoring is given as 10% to 21%. Because no standardized definition exists for snoring, these data, however, are not reliable.

The transition to obstructive sleep apnea is fluent, and the available literature regarding the distribution of obstructive sleep apnea in children can only be compared to a limited extent because different criteria for performing and evaluating the basic assessment procedures were applied.

However, it seems to be confirmed that obstructive sleep apnea has the highest prevalence in the age group of children between 2 and 8 years corresponding to the phase of lymphatic hyperplasia. Data in the literature regarding the incidence in otherwise healthy children amount to 1% to 4%, whereby boys seem to be affected more frequently than girls. The incidences in younger children or adolescents are unknown. The rela-

tionship between children with habitual snoring and children with obstructive sleep apnea amounts to 3:1 and 5:1, respectively. In correspondence to adult patients, the prevalence of obstructive sleep apnea in children is higher in the Afro-American population compared to Caucasian people.

However, with regard to the incidence of pediatric obstructive sleep apnea, it must be considered that the prevalence of the disease is significantly higher in high-risk cohorts. Based on polygraphic and polysomnographic trials, it can be expected that up to two thirds of the children with trisomy 21 are affected by obstructive sleep apnea.

In past decades, a change in the population of children suffering from obstructive sleep apnea could be observed. The incidence of children with concomitant obesity has significantly increased. Because of this development, an increasing number of cases of pediatric sleep apnea and an increasing number of complex cases that are difficult to treat must be expected.

11.2.2.4 Clinical Presentation

In both manifestations, that is, pediatric snoring and pediatric obstructive sleep apnea, *snoring* as defined by breathing noise during sleep noticed by an observer, is the leading symptom.

The fact that snoring might not be observed, however, does not exclude obstructive sleep apnea. Frequently, parents describe strained breathing, wheezing, or simply an intensive breathing noise. The assessment of what a normal breathing noise in children is and what acoustically indicates an increased breathing strain, however, is certainly subject to the individual estimation of the observer, and some parents are more attentive or even more anxious than others.

With increased airway obstruction, generally also the snoring noise increases, or irregularities of breathing are observed as well as hints of hypopnea or apnea. However, it must be mentioned that children much more rarely show the pattern of obstructive apnea that is typical for obstructive sleep apnea in adults. If parents report classic apnea at night, often a severe pediatric sleep apnea is already present.

As indications of airway obstruction or increased breathing efforts, indrawing of the intercostal space or paradoxical breathing during sleep may become apparent. In cases of longer-lasting

11.2 · Sleep-Related Breathing Disorders in Children

pediatric obstructive sleep apnea, the presentation of funnel chest may result. To reduce the airway resistance, children often adopt unfamiliar body positions during sleep; for example, they stretch their arms over their heads or prefer sleeping in an upright position. These children frequently sleep restlessly and often change body position. Further symptoms in this context are sweating at night, headaches in the morning, and prolonged or recurrent enuresis during sleep.

Practical Tip

Frequently, particularities of sleep behavior besides the respiratory disorder are found in children with obstructive sleep apnea: these include restlessness, sweating, or unusual sleeping positions that frequently change. The parents should be actively interviewed regarding those factors.

Comparable to adult age, in children respiratory obstruction during sleep also leads to the observation that sleep is not restorative even if the corresponding arousal reactions and fragmentations of the sleep profile are less significant than in adults. The consequences may be *impaired well-being* or *limited performance* during the day. Sometimes excessive daytime sleepiness can be observed, although this phenomenon is usually not reported spontaneously by children. If respective questionnaires or objectifying examinations such as a multiple sleep latency test (MSLT; see ► Chap. 2) are considered, signs of hypersomnia are frequently found, even if they are not as severe as it is typical for obstructive sleep apnea in adults.

Often children try to compensate their tiredness or sleepiness by *increased activity*, so hyperactivity or aggressive behavior may also indicate nocturnal breathing disorders. For this reason, the workup of pediatric hyperactivity and accompanying behavioral difficulties should include the differential diagnosis of sleep-related breathing disorder and also sleep disorders (see ► Sect. 11.2). Finally, more and more data are available confirming that obstructive sleep apnea also impairs the quality of life in children.

Practical Tip

Obstructive sleep apnea in children often manifests clinically by behavioral difficulties and hyperactivity, whereas daytime sleepiness relatively rarely is the complaint. So, in children with relevant behavioral difficulties sleep-related breathing disorder should be considered as a differential diagnosis.

Furthermore, pediatric obstructive sleep apnea may also lead to *cognitive deficits* and *deterioration of the school performance*. Particularly critical in this context is the fact that recent trials could also document behavioral difficulties and poorer school performance in children when these children only snore, that is, even when no other hints of obstructive sleep apnea were present. Thus, it can also be expected that isolated nocturnal snoring in children may already indicate a pathologically increased airway obstruction. This symptom may further lead to relevant impairment of the daytime vigilance and cognitive performance of the children, even if no other changes of nighttime breathing can be identified with the currently available methods. Those correlations especially make clear why strict differentiation between pediatric snoring and pediatric obstructive sleep apnea is not possible from a clinical point of view.

Finally, relevant *cardiovascular sequelae* and *metabolic changes* may also result in children:

- Sinus arrhythmia
- Pulmonary hypertension
- Pulmonary heart disease
- Systemic arterial hypertension
- Increased insulin resistance

Metabolic changes most often occur when additional obesity is present.

Relevant growth and development disorders may also be a sequela of an existing sleep-related breathing disorder. Even if the corresponding values are still in the normal range, nearly all children experience a development boost after successful therapy.

11.2.2.5 Examination Procedures

The basics of every diagnostic procedure consist of comprehensive *history taking* in which the aforementioned symptoms and hints have to be directly addressed, and the *clinical examination* that includes the assessment of size and weight as well as the general development status of the child.

In the clinical examination, the described anatomical predictors of pediatric sleep apnea have to be addressed. In the first place, these include possible obesity of the children as well as externally visible hints and malformations such as are typical for the mentioned syndromes and that are often associated with obstructive sleep apnea. However, adeno-tonsillar hyperplasia is certainly most significant, so that an intensive inspection of the oropharyngeal space is the standard examination for all children with suspected nocturnal breathing disorder. In this context, the size of the tonsils has to be examined, which might have impressive extensions up to so-called kissing tonsils, especially in pediatric patients (see [Fig. 11.9](#)). Further, enlarged adenoids have to be identified. Typical signs of pharyngeal obstruction in childhood in this context include:

- Increased or exclusive oral respiration
- Adenoid facies
- Closed nasality
- Frequent infection of the upper airways
- Persisting nasal secretion
- Eustachian tube dysfunction
- Otitis media with effusion (OME) with associated hearing loss

In addition, parents should be asked about hearing loss and probable existing delay of language development, and if necessary, middle-ear venti-



Fig. 11.9 Tonsillar hyperplasia in children

lation should be examined by means of otoscopy or ear microscopy as well as tympanometry.

Furthermore, a series of questionnaires exist to assess typical symptoms of pediatric sleep apnea. From the authors' point of view, the subscale for sleep-related breathing disorders of the Pediatric Sleep Questionnaire (PSQ-SRBD subscale) seems to be the most suitable. By means of this questionnaire, patients with pediatric sleep apnea can be identified with high reliability.

Further technical examination procedures for assessing the upper airway of pediatric patients with obstructive sleep apnea include endoscopic or radiological examinations as well as the assessment of the collapsibility of the airway. These techniques, however, have a key role in the scientific evaluation of the disease or in the context of specific questions and are currently not part of routine diagnostics.

11.2.2.6 Sleep-Related Medical Diagnostics

Objectifying sleep medical examination in the sense of *polysomnography* (PSG) is still the gold standard in the diagnostics of pediatric sleep apnea. Polysomnographic examinations in children are associated with higher staff-related and organizational efforts; they require the relevant technical equipment and specific experience.

Because of the described particularities, out of center sleep testing generally does not seem to be sufficient in children because of the low sensitivity to exclude a relevant sleep-related breathing disorder. Although a recent comparative study showed that pediatric obstructive sleep apnea in older children (in this context, >10 years) can generally be diagnosed by means of outpatient recording polygraphic examinations in infants and preschool children are almost nonsignificant or can only be used in cases of clearly pathological findings. In a recently published position paper, the American Academy of Sleep Medicine draws the conclusion that a home sleep apnea test for diagnosing pediatric sleep apnea cannot be recommended. Alternative examination procedures such as home *audio or video recordings* or an isolated nocturnal *pulse oximetry* are not sufficiently sensitive, and at best they can only provide diagnostic hints.

Regarding polysomnographic examinations in children with suspected obstructive sleep-related breathing disorder, a series of particularities should be observed. In the context of evaluating respiratory events it must be considered that for

the definition of obstructive apnea no comparable rigid time limits (e.g., 10 s) exist, but the duration of the respiratory event relative to the duration of two previous cycles of regular respiratory activity is considered as a measure. If two cycles of unimpaird inspiration and expiration are measured in the PSG, for example, with 6 s, a subsequently occurring respiratory event (e.g., apnea) is registered when it lasts longer than 6 s.

In analogy to the adult age, the breathing disorder may manifest as a typical cyclic sequence of apneas or also be associated with longer episodes of partial airway obstruction in the sense of obstructive hypoventilation with hypercapnia and desaturation. Furthermore, respiratory-related arousals are found more rarely in children because of their higher arousal levels. The hypnogram is generally less remarkable than in adults. If airflow limitations, apneas or hypopneas occur in children, they are frequently associated with significant desaturations because of the high breathing rate and low functional reserve.

CO_2 measurement at nighttime is generally not required if it is the case of routine diagnostics of obstructive sleep-related breathing disorders, even if the ICSD-3 defines obstructive hypoventilation as an alternative diagnostic criterion regarding the presence of hypercapnia. For differentiation against a respective nonobstructive breathing disorder, it may be very useful.

In addition to diagnostics of obstructive sleep-related breathing disorder, a *video documentation* at nighttime may be suitable to identify the described secondary signs of airway obstruction such as oral respiration, jugular or thoracic indrawings, or exceptional sleeping positions. During the night of documentation, it may also be helpful to observe the child in his/her sleep at the bedside to identify the presentation of the breathing disorder. In particular, the acoustic aspects of breathing disorders can be better assessed in this way compared to merely technical monitoring.

Practical Tip

The criteria for definition of respiratory events in children are significantly different in some aspects from those for adults. Under no circumstances can the evaluation and assessment criteria of polysomnography in adults be transferred to children.

According to the criteria of the AASM, polysomnography is required for diagnosis of pediatric sleep apnea. If in otherwise healthy children with clear history, typical symptoms, and apparent adeno-tonsillar hyperplasia are presented, objectifying sleep medical examinations before introduction of antiinflammatory or surgical therapy are not routinely required and from a practical point of view are not always possible. In these cases, the symptomatic adeno-tonsillar hyperplasia is the leading diagnosis and thus indication for therapy.

An indication for polysomnography, however, is obvious in the following constellations:

- Children with more complex craniofacial malformations or syndromic diseases
- Children with neuromuscular diseases
- Children with severe obesity
- Before introduction of ventilation therapy
- In cases of nondirective clinical findings (missing adeno-tonsillar hyperplasia)
- In cases of persisting complaints after surgical therapy

Case Report

A young mother presents her 4.5-year-old son Ian who, according to the parents, has been snoring increasingly in the course of the previous 6 months. Being asked, the parents report that they have observed breathing interruptions in the past weeks. In the morning, the bed is rumpled, and the boy wakes up at night again and again. During the day, according to the mother, Ian can barely be kept under control, and in kindergarten which he previously has attended without any problems, more and more conflicts with other children must be managed. Furthermore, he often suffers from a common cold and would then breathe only through the mouth and even hear poorly. Previous medical checkups were all unremarkable; the boy has a good health status.

The clinical examination reveals a slender boy who is otherwise regularly developed. The most prominent findings are massively enlarged palatal tonsils and relevantly enlarged adenoids appearing in the examination of the nasopharynx. Ear microscopy shows a retracted eardrum with middle-ear effusion; the tympanogram appears flat on both sides.

The diagnosis of bilateral adeno-tonsillar hyperplasia with middle-ear effusion is made as well as the suspicion of pediatric obstructive

sleep apnea, which is confirmed by a conspicuous score in the respective questionnaire (PSQ-SRBD). Based on the clear symptoms, polysomnography is not performed, and adenotomy and tonsillectomy with insertion of tympanostomy tubes are indicated. Surgery and postoperative healing take place without complications.

In a follow-up examination, the mother reports the nighttime breathing disorder has ceased, with a relevant improvement of his well-being during daytime. In the months after the intervention, her son has experienced a physical development boost, and the problems in his social environment have significantly improved. Under these circumstances, postoperative control-PSG is not performed.

11.2.2.7 Differential Diagnoses

In the clinical routine, a differentiation of *nonobstructive sleep-related breathing disorders* may be difficult, especially when in the individual case such a breathing disorder is associated with an obstructive component or overlapping is observed.

In the context of central sleep apnea, classically thoracic and abdominal breathing excursions are missing; in cases of hypoventilation syndromes, however, typically snoring or hints of paradox breathing are not found. In particular, in severely obese children signs of airway obstruction as well as hypoventilation are observed.

If nocturnal snoring is observed in children, it nearly always indicates airway obstruction or increased airway resistance. It is then important to identify the severity and the clinical relevance of the airway obstruction. The clear differentiation of obstructive sleep apnea from *snoring* may be difficult even with PSG because the transitions are fluent.

Peculiar nocturnal movements or positions must sometimes be differentiated from pediatric *parasomnias* (see ► Chap. 7). In the context of hypersomnia without any hint of obstructive sleep-related breathing disorder, other origins of hypersomnia have to be excluded, as, for example, *restless legs syndrome*, *periodic limb movements* (see ► Chap. 8), or *narcolepsy* (see ► Chap. 5). A differentiation of nocturnal *epilepsy* may

further require the performance of a complete sleep EEG.

If behavioral difficulties are the leading symptom, differential diagnostics of neurological and psychiatric diseases may be indicated.

11.2.2.8 Treatment

In analogy to the treatment of obstructive sleep-related breathing disorders in adults, the treatment of children may also be classified into conservative, device-related, and surgical concepts.

Conservative Treatment

Regarding all overweight or obese children suffering from snoring or obstructive sleep apnea, a reduction of body weight should be achieved, and the parents should be informed about the significance of obesity for the development of pediatric breathing disorders (as well as other problems and diseases, of course). It seems to be necessary not only to state an appeal but also to give specific recommendations. Because the therapy of pediatric obesity, in particular, severe obesity, is highly complex and not every sleep professional acquires the relevant experience, it is recommended to obtain an overview of the locally available sites and institutions that might offer or provide the required therapeutic concepts. Those sources may include specially trained and experienced pediatricians but also training programs of the health insurance.

In the past years, the data regarding topical nasal steroids significantly improved so that their effectiveness in the context of pediatric snoring as well as pediatric obstructive sleep apnea is meanwhile confirmed. Because of the high tolerance, a conservative treatment attempt is generally justified and often achieves a successful outcome. In cases of severe symptoms, severe tonsillar hyperplasia, or hearing loss existing for a longer time because of an impaired Eustachian tube ventilation, however, surgical therapy should not be delayed.

If the respiratory situation is aggravated by infections, the timely restricted application of decongesting nose drops or spray, adapted to the child's age, may also be indicated. In particular for persisting problems, it must be discussed if *adenotomy* performed on an outpatient basis cannot be preferred.

Device-Related Therapy

For treatment of obstructive sleep apnea in children, different orthodontic treatments are available; however, they have not all been scientifically verified to date. Hereby, the (forced) *rapid palatal expansion* is of particular interest, which consists of the expansion of the still open midpalatal suture by means of an intraoral distractor that may be applied in children. The phase of active expansion generally takes only a few weeks (“rapid” palatal expansion). Afterward, the phase of consolidation follows. By means of this technique, the maxilla and thus the midfacial structures may be expanded relevantly in the transversal axis. The children’s airways may be significantly enlarged in this way, and the existing sleep-related breathing disorder is improved.

In cases of respective conspicuities such as retrognathia, dental malposition, maxillary constriction (narrow, high palate), or midfacial hypoplasia, a specific *orthodontic consultation* and *examination* should be performed. This examination is particularly important when no adeno-tonsillar hyperplasia is found or the breathing disorder persists after surgical therapy.

Nocturnal positive airway pressure therapy for obstructive sleep-related breathing disorder alone is only rarely required in children because in this age group the alternative (especially surgical) therapies are very effective. Frequently, ventilation therapy is necessary when the children suffer from severe malformations that cannot be corrected currently or in the long term. Further, severe obesity with respective hypoventilation and airway obstruction may require ventilation therapy in individual cases.

The implementation of ventilation therapy is performed in analogy to the adult treatment in form of a nocturnal continuous positive airway pressure (CPAP) therapy that is generally applied nasally also in children. Even if the introduction of ventilation therapy in children requires particular experience and intensive counseling, generally the compliance is not poorer than in adults. It is certainly most decisive that parents or reference persons of the child can be convinced of the necessity of the treatment and commit themselves accordingly.

Regarding the application of CPAP therapy in children, however, one must bear in mind that this therapy may lead to midfacial growth retardation or impairment of the child’s cranium,

which may further aggravate the underlying sleep apnea. The necessity of CPAP therapy in children should be regularly checked, and the fitting of the mask should be adjusted at regular intervals.

Practical Tip

Because of the problems of long-term ventilation therapy in children (e.g., with regard to the development of midfacial hypoplasia), the necessity of ventilation therapy or the possibility of applying alternative measures in children should be regularly verified.

Surgical Therapy

In contrast to the adult age group, the surgical therapy of obstructive sleep-related breathing disorders of infancy is not controversially discussed, and because of its high effectiveness, it is meanwhile widely distributed. The most important surgical intervention is at the same time one of the most frequently performed operations in children: the (partial) *resection of the pharyngeal and palatal tonsils*.

The success rates regarding polysomnographically confirmed elimination of respiratory events amount to 75 to 100%, according to the scientific literature, and also the respective improvement of the already described clinical symptoms seems to be evident even if the perceived clinical improvement does not always correlate with the polysomnographic outcome. Because of the effectiveness of the intervention, (adeno-)tonsillectomy is internationally considered as the standard procedure for therapy of pediatric obstructive sleep apnea in cases in which hyperplasia of the pharyngeal and palatal tonsils is found in the clinical examination and no contraindications exist. In a large patient population of more than 450 children suffering from obstructive sleep apnea, a recent randomized trial performed in the US compared the outcome after tonsillectomy with a wait-and-see strategy. This elaborate project allowed important insights in the surgical therapy of pediatric obstructive sleep apnea and could confirm that surgical therapy is highly superior to wait and see with regard to the normalization of polysomnographic parameters. However, it became also clear that in the control group that did not undergo therapy, an

important percentage of the children experienced a normalization of the sleep laboratory findings during the evaluation period of 7 months, which confirms the frequently self-limiting character of the disease in the context of physiological hyperplasia of the palatal tonsils in this age group. Furthermore, it became evident that even tonsillectomy does not always lead to healing of the breathing disorder. In particular, children with severe sleep apnea, obesity, or craniofacial malformations may expect postoperative persistence of the disease, which confirms the necessity of clinical and in cases of doubt also objectifying control, in particular in this last-mentioned cohort. The indication to perform tonsillectomy has to be made in a highly differentiated way and further has to take into account the severity of the disease, expected course of the disease, clinical complaints, risks that are associated with the intervention, and the parents' hopes and expectations.

Practical Tip

Surgery of the tonsils, if needed also in combination with adenotomy, is the most important therapeutic measure in the context of pediatric obstructive sleep apnea, in particular with existing hyperplasia of pharyngeal and palatal tonsils. Because of the high effectiveness, it is the treatment of first choice even when aggravating factors such as obesity or craniofacial malformations are also found.

In some European countries, partial resection of tonsils (tonsillotomy) is recommended or even exclusively performed as an alternative to tonsillectomy, mentioning the reduced postoperative risks and the lower postoperative morbidity. If tonsillotomy is really comparable to tonsillectomy regarding its therapeutic effect in the context of pediatric sleep apnea, cannot be estimated based on the reduced data available and generally depends on the surgical technique used. Besides adeno-tonsillectomy, a series of other surgical procedures must be mentioned even if they are not frequently used. For children with severe retrognathia, as is typical for certain malformation

syndromes, distraction osteoneogenesis may be helpful and avoid ventilation therapy or tracheostomy of these children. Tracheostomy is necessary only in exceptional cases or for bridging airway obstructions that otherwise cannot be directly eliminated. With this indication, it is highly effective. Also, children with a breathing disorder resulting from laryngomalacia may benefit from relevant surgical interventions (e.g., supraglottoplasty).

11.3 Questions

1. Please describe the similarities and differences of the clinical symptoms of sleep disorders in children and ADHD disease.
2. Please list questionnaires that assess sleep disorders in children from the parents' and the children's perspective.
3. Which interventions should be applied for treatment of insomnia in children and adolescents?
4. Which interventions should be applied for treatment of nightmares in children and adolescents?
5. Please describe the similarities and differences of the clinical symptoms of obstructive sleep apnea in adults and children.
6. Please explain the polysomnographic criteria of obstructive sleep apnea in children.
7. Please list the most important origins of obstructive sleep apnea in children.
8. Please characterize the most important therapeutic options in the context of pediatric obstructive sleep apnea and list the indications for these procedures.
9. Please explain practical problems that occur in the differentiation of pediatric snoring and obstructive sleep apnea.

References

1. American Academy of Pediatrics, Section on Pediatric Pulmonology, Subcommittee on Obstructive Sleep Apnea Syndrome. Clinical practice guidelines: diagnosis and management of childhood obstructive sleep apnea syndrome. *Pediatrics*. 2002;109:704–12.
2. American Academy of Sleep Medicine. International classification of sleep disorders, 2. Aufl. Diagnostic and coding manual. Westchester: American Academy of Sleep Medicine; 2005.
3. BORBÉLY AA. Sleep mechanisms. *Sleep and Biological Rhythms*. 2004;2:67–68.
4. Cattarius B, Schlarb AA. Gegenseitige Beeinflussung von Eltern und Babys in ihrem Schlafverhalten. *Somnology*. 2016;20(3):189–198.
5. Capdevila OS, Kheirandish-Gozal L, Dayyat E, Gozal D. Pediatric obstructive sleep apnea. Complications, management, and long-term outcome. *Proc Am Thorac Soc*. 2008;5:274–82.
6. Fricke L, Lehmkuhl G. Schlafstörungen im Kindes- und Jugendalter. Ein Therapiemanual für die Praxis. Göttingen: Hogrefe; 2006.
7. Fricke-Oerkemann L, Plück J, Schredl M, et al. Prevalence and course of sleep problems in childhood. *Sleep*. 2007;30:1371–7.
8. Fricke-Oerkemann L, Frölich J, Lehmkuhl G, Wiater A. Schlafstörungen – Leitfaden Kinder- und Jugendpsychotherapie. Göttingen: Hogrefe; 2007.
9. Handwerker G. Epworth-Sleepiness-Scale für Kinder (ESS-K). In: Schulz H, editor. *Kompendium Schlafmedizin*, III-2.3.7.1. Landsberg/Lech: Ecomed; 2002.
10. Kirk V, Baughn J, D'Andrea L, Friedman N, Galion A, Garetz S, Hassan F, Wrede J, Harrod CG, Malhotra RK. American Academy of Sleep Medicine position paper for the use of a home sleep apnea test for the diagnosis of OSA in children. *J Clin Sleep Med*. 2017;13:1199–203.
11. Roeser K, Schwerdtle B, Kübler A, Schlarb AA. Further evidence for the JuSt program as treatment for insomnia in adolescents: results from a 1-year follow-up study. *J Clin Sleep Med*. 2016;12:257–62. <https://doi.org/10.5664/jcsm.5496>.
12. Roffwarg, H. P., Muzio, J. N., & Dement, W. C. (1966). Ontogenetic development of the human sleep-dream cycle. *Science*, 152(3722), 604–19.
13. Sadeh A, Anders TF. Infant sleep problems: origins, assessment, interventions. *Infant Ment Health J*. 1993;14:17–34.
14. Schlarb AA. JuSt-Therapeutenmanual: Das Training für Jugendliche ab 11 Jahren mit Schlafstörungen. Stuttgart: Kohlhammer; 2012.
15. Schlarb AA. Just – Begleit- und Arbeitsbuch für Jugendliche, Das Training für Jugendliche ab 11 Jahren mit Schlafstörungen. Stuttgart: Kohlhammer; 2012.
16. Schlarb AA. Mini-KiSS – Begleit und Arbeitsbuch für Eltern, Das Elterntaining für Kinder bis 4 Jahre mit Schlafstörungen. Stuttgart: Kohlhammer; 2013.
17. Schlarb AA. Mini-KiSS, Therapeutenmanual. Das Elterntaining für Kinder bis 4 Jahre mit Schlafstörungen, 1. Aufl. Stuttgart: Kohlhammer; 2013.
18. Schlarb AA. KiSS – Begleit- und Arbeitsbuch für Eltern und Kinder, Das Training für Kinder von 5 bis 10 Jahren mit Schlafstörungen. Stuttgart: Kohlhammer; 2014.
19. Schlarb AA. KiSS-Therapeutenmanual. Das Training für Kinder von 5–10 Jahren mit Schlafstörungen. Stuttgart: Kohlhammer; 2014.
20. Schlarb A, Brandhorst. Mini-KiSS online: an internet-based intervention program for parents of young children with sleep problems; influence on parental behavior and children's sleep. *Nat Sci Sleep*. 2012;4:41–52. <https://doi.org/10.2147/NSS.S28337>.
21. Schlarb A, Gulewitsch MD. Wenn der Sandmann kommt. Wirkt Hypnotherapie bei Kindern mit Schlafstörungen? *Hypnose-ZHH*. 2010;5(1+2):189–98.
22. Schlarb A, Hust C, Hautzinger M. Insomnie bei Jugendlichen. Psychologische Einflussfaktoren und Empfehlungen zur Diagnostik im pädiatrischen Alltag. *Pädiatrische Praxis*. 2009;74:419–30.
23. Schlarb AA, Schwerdtle B, Hautzinger M. Validation and psychometric properties of the German version of the children's sleep habits questionnaire (CSHQ-DE). *Somnologie*. 2010;4:260–6.
24. Schlarb AA, Liddle CC, Hautzinger M. JuSt: a multimodal program for treatment of insomnia in adolescents: a pilot study. *Nat Sci Sleep*. 2011;3:13–20.
25. Schlarb AA, Gulewitsch MD, Weltzer V, Ellert U, Enck P. Sleep duration and sleep problems in a representative sample of German children and adolescents. *Health*. 2015;7:1397–408.
26. Schlarb AA, Zschoche M, Schredl M. Der Nightmare effects questionnaire (NEQ). *Somnologie*. 2016;20:251–7.
27. Schwerdtle B, Kanis J, Kahl L, Kubler A, Schlarb AA. Children's sleep comic: development of a new diagnostic tool for children with sleep disorders. *Nat Sci Sleep*. 2012;4:97–102. <https://doi.org/10.2147/NSS.S33127>.
28. Schwerdtle B, Kanis JA, Kübler A, Schlarb AA (2014) The children sleep comic – a new self-rating tool for childhood insomnia. *J Sleep Res*:315.
29. Schwerdtle B, Kanis JA, Kubler A, Schlarb AA. The children's sleep comic: psychometrics of a self-rating instrument for childhood insomnia. *Child Psychiatr Hum Dev*. 2016;47:53–63. <https://doi.org/10.1007/s10578-015-0542-2>.
30. Stehling F, Keull J, Olivier M, Große-Onnebrink J, Melles U, Stuck BA. Validation of the screening tool ApneaLink® in comparison to polysomnography for the diagnosis of sleep-disordered breathing in children and adolescents. *Sleep Med*. 2017;37:13–8.
31. Stores G, Wiggs L. Sleep disturbances in children and adolescents with disorders of development: its significance and management. London: Mac Keith Press; 2001.
32. Stuck BA, Götte K, Windfuhr JP, Genzwürker H, Schrotten H, Tenenbaum T. Tonsillectomy in children. *Dtsch Arztebl Int*. 2008;105:852–60.

33. Wise MS, Nichols CD, Grigg-Damberger MM, Marcus CL, Witmans MB, Kirk VG, D'Andrea LA, Hoban TF. Executive summary of respiratory indications for polysomnography in children: an evidence-based review. *Sleep*. 2011;34:389–98.
34. Zschoche M, Schlarb AA. Is there an association between insomnia symptoms, aggressive behavior, and suicidality in adolescents? *Adolesc Health Med Ther*. 2015;6:29–36. <https://doi.org/10.2147/AHMT.S76511>.