



CLINICAL REVIEW

Sleep problems in autism spectrum disorders: Prevalence, nature, & possible biopsychosocial aetiologies

Amanda L. Richdale^{a,*}, Kimberly A. Schreck^{b,c}

^aOlga Tennison Autism Research Centre, School of Psychological Science, La Trobe University, Bundoora, VIC 3086, Australia

^bPenn State University, 777 W. Harrisburg Pike, W311 Olmsted Building, Middletown, PA 17057-4898, USA

S U M M A R Y

Keywords:

Autism
Asperger's syndrome
Sleep
Sleep disorders
Aetiology

As considerably more people are diagnosed with an autism spectrum disorder (ASD), interest in the associated behaviours, including sleep problems has increased. This has resulted in a subsequent increase in the research related to the sleep problems occurring in people with an ASD. This article summarizes and evaluates the current literature related to a) the higher prevalence of a sleep problem compared to typically developing children, b) the specific types of sleep problems for people with an ASD, and c) the possible aetiology of sleep problems in the ASDs within a biopsychosocial framework. It is concluded that recent studies confirm that the majority of this population are likely to experience sleep difficulties, with settling issues in children with an ASD the most commonly reported. However, exploration of the types of sleep difficulties and associated aetiological factors in the ASDs is still in its infancy.

© 2009 Elsevier Ltd. All rights reserved.

It is generally agreed that the incidence of autism spectrum disorders (ASDs) has been increasing and the estimated population prevalence is now 0.6%.¹ These disorders (autism, Asperger syndrome (AS) and pervasive developmental disorder not otherwise specified) affect all areas of a child's development, including communication, socialisation, and behaviour.² Patterns of other commonly occurring behaviours include sleep difficulties.² Through a variety of measurement procedures, including sleep EEG or polysomnography (PSG), actigraphy, sleep diary, and sleep questionnaire studies, as we will show, research predominantly has supported the observation that people with an ASD experience more sleep problems than the general population. As sleep issues are increasingly observed and supported over the last 10 years, more professionals are routinely asked to identify and treat these sleep problems and possibly related behaviours. This review will discuss and evaluate sleep problems in ASDs with reference to a) prevalence, b) nature, and c) potential aetiology.

Prevalence of sleep problems in autism spectrum disorders

The prevalence of sleep problems in any population is affected by several variables, including criteria used to define and measure the sleep problem, age, IQ (Intelligence Quotient), informant,

sampling, and sample size. The criteria and definitions of sleep problems are particularly affected in paediatric research because no clear consensus on sleep disorder definitions exist. Generally researchers do not use classificatory systems such as the DSM-IV-TR (Diagnostic and Statistical Manual of Mental Disorders (4th ed.)–Text Revision),² ICD-10 (International Classification of Diseases (10th ed.)),³ or ICSD-2 (International Classification of Sleep Disorders)⁴ or its predecessors. Researchers typically construct their own criteria or definitions of sleep problems, such as cut-off or frequency scores on sleep questionnaires or diaries, or based on parent-report that a sleep problem is present.

The issue of sleep problem measurement is further complicated when measuring children's sleep. Adults with sleep difficulties can report directly to health care providers. However, measurement and description of childhood sleep problems, especially for children with developmental disabilities (DDs) such as ASD, differ as a parent or another responsible adult (e.g., teacher) generally reports and describes the problem. Information may be sought directly from older typically developing (TD) children and adolescents, but where children have an intellectual disability (ID), DD, or ASD parents or carers are likely to be the major source of information about sleep through to adulthood. It can be argued that if the parent believes that there is a sleep problem then some investigation is warranted, even if only to eliminate the child's sleep as the primary issue of concern.

Despite this variability in research definitions and measurement, sleep problems are commonly reported in TD children. For children in the age range 0–6 years as many as 50% may have a sleep problem and on average 25% of all children will experience

* Corresponding author. Tel.: +61 (0) 3 9479 2497; fax: +61 (0) 3 9479 1956.

E-mail addresses: a.richdale@latrobe.edu.au (A.L. Richdale), kas24@psu.edu (K.A. Schreck).

^c Tel.: +1 717 948 6048; fax: +1 717 948 6519.

Abbreviations

ADHD	Attention Deficit Hyperactivity Disorder
AS	Asperger syndrome
ASD	autism spectrum disorder. Includes autism, pervasive developmental disorder, and Asperger's syndrome
CAP	cyclic alternating pattern
CBCL	child behavior checklist
CSHQ	Children's Sleep Habits Questionnaire
DD	developmental disability
DS	Down syndrome
DSM-IV-TR	Diagnostic and Statistical Manual of Mental Disorders (4th ed.) – Text Revision.
GARS	Gilliam Autism Rating Scale

ICD-10	International Classification of Diseases (10th ed.)
ICSD-2	International Classification of Sleep Disorders
ID	intellectual disability
IQ	Intelligence Quotient
NREM	non-rapid eye movement sleep
OSA	Obstructive Sleep Apnoea
PDDNOS	pervasive developmental disorder not otherwise specified
PLMS	Periodic Limb Movements in Sleep
PSG	polysomnography
PWS	Prader–Willi syndrome
REM	rapid eye movement sleep
SW sleep	slow wave sleep
TD	typically developing

sleep difficulties at some time.⁵ When an ID (IQ < 70) or DD is present sleep problems may be found in up to 80% of children.⁵

Children and adolescents with an ASD are particularly vulnerable to sleep difficulties, regardless of their age or IQ with around two-thirds having a sleep problem at some point in childhood.⁶ Sleep problems are persistent in ASDs, for example 63% of children with a parent-reported past sleep problem also had a current sleep problem.⁷ Studies continue to find parent-reported sleep problem rates ranging from around 50% to 80% for children with an ASD compared with 9% to 50% for comparison groups.^{8–11} The prevalence of parent-reported sleep problems is potentially affected by sample size and sample composition. Nevertheless, there are now sleep studies that include around 200–300 children^{12–14} with an ASD. Children and young adults with AS also self-report a higher rate of sleep problems than TD peers.^{15–17} Overall the high rate of parent-reported sleep problems in the ASDs found in earlier studies⁶ continues to be supported by more recent research.

While some report that there may be an increased proportion of more developmentally delayed children with an ASD and sleep problems¹⁸ many recent studies with high rates of parent-reported sleep problems have predominantly examined high-functioning children (IQ > 70). The frequency of sleep problems in low-functioning adults with autism may be similar to that of adults with an ID,¹⁹ which may reflect the generally higher rate of sleep difficulties in individuals with an ID compared with TD individuals. However, the lack of association of sleep problems with IQ in children was again supported in a recent population-based study of 2–5 year-olds with an ASD.¹³ This study is also consistent with previous sleep disorder prevalence estimates with 52.5% of young children with an ASD having a parent-reported sleep problem compared with 46% of children with a DD and 31.9% of TD children.¹³ Nevertheless in early childhood, those who have a DD or are TD may have comparably high rates of sleep problems to young children with an ASD.²⁰

A further difficulty in determining prevalence of sleep problems in children with an ASD is that comparison groups are often composed of mixed disabilities²⁰ that can present with differing types of sleep problems. For example parent-reported sleep problems in TD children and children with autism, Prader–Willi syndrome (PWS) or Down syndrome (DS) showed that settling difficulties significantly differentiated the children with autism from the other groups, while excessive daytime sleepiness differentiated children with PWS.²¹ Thus individual disabilities can be differentiated by type of sleep problem reported. Consequently, in mixed comparison groups, sample composition may affect our understanding of prevalence data and reported susceptibility to certain types of sleep problems if the individual DDs comprising the group are ignored. Despite the issues involved in determining

prevalence rates of sleep problems, it is clear that high rates of sleep problems are common in ASDs.

Practice points

1. Increased prevalence of sleep problems is commonly reported for children with an ASD.
2. The influence of IQ or intellectual functioning on sleep problems for children with an ASD is sometimes contradictory.

Research agenda

In future studies it will be important to:

1. Avoid or control for mixed DD comparison groups when assessing sleep in ASD.
2. Assess potential differences across specific DDs and ASD when examining the frequency of sleep problems.
3. Control for IQ and other measures of functioning levels in determining the influence of these factors on sleep problems in ASDs.
4. Use standardized sleep disorder definitions when assessing sleep in ASD.

Types of sleep problems in ASDs

Within the scope of this article, it is impossible to define and describe all sleep disorders commonly occurring for children. Consequently, readers are directed to Sheldon et al.'s⁵ comprehensive book on paediatric sleep for a description of insomnia, parasomnia, circadian rhythm sleep disturbances, and other sleep disturbances in TD children. Among the sleep problems most commonly found in children, sleep onset and maintenance problems, and sleep duration are consistently the most predominant concerns expressed by parents of children with an ASD that is, symptoms of insomnia.¹¹ In Table 1 we have arranged the reported sleep problems against the eight ICSD-2⁴ broad criteria for classifying sleep disorders to give a sense of the range and scope of sleep difficulties that are reported for children with an ASD. The most commonly reported sleep problems are those consistent with disorders classified within the ICSD's "Behavioral Insomnia of

Table 1

Sleep problems or disorders reported in autism spectrum disorders and actual or likely broad ICSD-2 classifications.

ICSD-2 ^a classification	Reported sleep problem or disorder ^a
Insomnia	Settling difficulties, co-sleeping, night waking, low sleep efficiency, long sleep latency, early waking, problematic bedtime routines, daytime sleepiness
Parasomnias	Nightmares, wakes screaming, enuresis ^b
Hypersomnias of central origin	Kleine–Levin syndrome, hypersomnia, daytime sleepiness
Sleep-related breathing disorders	OSA, sleep disordered breathing
Sleep-related movement disorders	PLMS, restless sleep
Isolated symptoms, apparently normal variants, and unresolved issues	Short sleep, early waking
Other sleep disorders	Abnormal objective sleep patterns (actigraphy)
Circadian rhythm sleep disorders	Late sleep onset, long sleep latency, early waking, irregular sleep–wake patterns, free-running sleep

Abbreviations: ICSD-2, International Classification of Sleep Disorders; OSA, Obstructive Sleep Apnoea; PLMS, Periodic Limb Movements in Sleep.

^a Sleep problems or disorders in this table have been reported in one or more of the references in the current reference list.

^b Not typically investigated in relation to sleep in ASDs, toilet training can be a major issue and parents do sometimes report that their child is woken for toileting or wets the bed, i.e., enuresis.³⁵

Childhood”.⁴ The studies contributing to these results regarding sleep problems in ASDs range from subjective retrospective and prospective report (generally by parents) to objective measures via actigraphy and PSG.

Parent reported sleep problems in ASDs

In children with an ASD, settling and night-waking problems (insomnia) are often associated with inappropriate bedtime routines or bedtime associations (e.g., drinking from a bottle after infancy, falling asleep on the couch instead of in a bed, etc.),²² but may also be associated with anxiety, particularly at older ages and in AS. Almost all authors report settling problems, with some children with ASD taking several hours to fall asleep.^{6,11,13,21} Additionally parent report of sleep difficulties is stable over at least a 3-month interval.²³ Young children classified as poor sleepers based on moderate or severe parental concerns about sleep had poorer sleep efficiency and longer sleep latency on PSG with increased sleep latency also confirmed by sleep diary.¹¹

According to parent report, night waking is also common for children with an ASD, but the frequency of waking is often similar to that found in comparison children. What is more unusual than the frequency of night waking is that in children with an ASD lengthy periods of night waking (up to 2 or 3 h) are reported where the child may simply laugh or talk (vocalise), wake in the night screaming, or get up and “play” with toys/objects in the room.^{6,11,24} Screaming may be associated with night terrors or nightmares but this has not been explored in structured research.²⁵ In general, these types and duration of night waking are not typical of other DDs or TD children to our knowledge.

Reduced total sleep is also commonly, though not universally reported by parents.²⁵ Children with AS are also more likely to self-report too little sleep and daytime tiredness than are TD children.¹⁵ While reduced total sleep is commonly found in ASD, particularly autism, an increase in total sleep as well as daytime sleepiness (hypersomnia, daytime somnolence) associated with a diagnosis of AS has been reported.^{6,15}

Other less commonly reported sleep problems for children with an ASD may also include fragmented, irregular sleep–wake patterns (variability in sleep onset and waking across 24 h)^{6,23,26,27} or free-

running sleep–wake rhythm (not entrained to 24 h),^{26, 27} late sleep onset (sleep onset inappropriately late for age; e.g., child < 6 years falling asleep at 12 midnight)^{6,26,27} and early morning waking (before 6 am and as early as 2 am)^{6,26,27}; sleep apnoea^{25,28}; or parasomnias.^{10,12,25,29} Symptoms associated with sleep apnoea (e.g., snoring) are not often reported. Polimeni et al.¹⁰ report that other parasomnias in general are more prevalent in AS than in autism. In younger or lower functioning children, the child cannot communicate the reason for their waking or any accompanying distress which can make it difficult to determine why the child has woken and is upset. This makes diagnosis of parasomnias through parent-report difficult. Currently though, only preliminary evidence exists that sleep problems other than settling or sleep onset issues may differentiate sleep in ASDs from sleep in other DDs or TD children.

Types of sleep problems: Objective sleep reports

Actigraphy

While a range of parent-reported sleep problems in ASD exists, sleep diaries and questionnaires only reveal parentally observed sleep behaviours and those that disturb families. Thus there is a risk that important and informative sleep behaviours are unreported or under-reported. Nevertheless, studies show good agreement between parent-report of sleep onset and sleep length and actigraphy and both parent-report and actigraphy can complement each other.³⁰

Several actigraphy studies, together with sleep questionnaires or diaries have now been conducted on children with an ASD,^{7,8,20,31} adolescents and adults with AS,^{32, 33} and adults with autism.¹⁹ In the majority of these studies sleep in ASD differs on one or more parameters from those of controls or a normative sample. Actigraphy results largely confirm parent or care-giver reports that people with an ASD exhibit symptoms of insomnia across a range of ages and cognitive functioning.

In the largest actigraphy study, 62 children with an ASD had “compromised sleep quality” compared with normative data, even when there was not a parent-reported sleep problem.⁷ Where sleep problems were reported actigraphy often did not conform to usual diagnostic patterns. In this study,⁷ 67% of parents said their child had a current sleep problem. Actigraphy results confirmed increased sleep latency and night waking, and low sleep efficiency. In a mixed group of toddlers and preschoolers who were TD, or had an ASD or DD, sleep problems reported on the Children’s Sleep Habits Questionnaire (CSHQ) correlated significantly with corresponding actigraphic data.²⁰ Similarly other actigraphy studies reveal increased sleep latency and poor sleep efficiency in 8 of 10 adolescents and young adults with ASD, whereas few of these young people were reported as having poor sleep.³³ Increased sleep fragmentation also has been found in adults with AS.³² However, on actigraphy adults with low-functioning autism may have sleep that does not differ from that in adults with an ID.¹⁹

Polysomnography

Since actigraphy is based on body movements and is also subject to measurement error,³⁰ PSG is considered the gold standard in sleep measurement. While PSG is not practicable or warranted for most general paediatric sleep problems, PSG studies can confirm parent-report and actigraphy results, and additionally can provide information regarding whether or not sleep structure is normal.

There now are at least 20 PSG studies involving participants with an ASD that generally support the presence of disordered sleep and/or PSG abnormalities in ASD. Participants with an ASD include children and adults, with ID or normal IQ. Reports include reduced rapid eye movement sleep (REM) latency, reduced eye movement density during REM, increased muscle twitches,

decreased sleep spindles in Stage 2 sleep, alterations in the amount of Stage 1 sleep (mainly increased), decreased slow wave (SW) sleep, alterations to sleep microstructure, lack of dream reports on waking from REM, increased sleep latency, decreased sleep efficiency, increased night waking, decreased sleep length and PLMS (Periodic Limb Movements in Sleep).^{6,34,35,36,37,38,39,40} However, in one study PSG in 20 young adults with AS was not different from 10 matched controls.¹⁷

Miano et al.³⁸ investigated non-rapid eye movement sleep (NREM) microstructure, conducting PSG on 16 children with autism and ID. Compared with TD controls, children with autism had reduced total sleep, shorter REM latency and lower cyclic alternating pattern (CAP) rate (physiologic measure of NREM sleep microstructure) during SW sleep was found. CAP rate reduction in SW sleep was suggested “to be a peculiar alteration of sleep” (p. 69) in this autism sample. However children with AS have problems with sleep onset, restless sleep, daytime sleepiness, with more stage shifts per hour on PSG than children with autism or TD children, increases in CAP rate in SW sleep and a decrease in Stage 2 sleep.⁴⁰ Both ASD groups show a trend for increased sleep latency. The AS group also have reduced CAP rate in Stage 1 and 2 sleep compared with TD children, but compared with children with autism there was an increase in CAP rate in SW sleep and a decrease in Stage 2 sleep.⁴⁰ Thus sleep microstructure differed in the two ASD groups, but whether or not this relates to differences between autism and AS or differences in cognitive functioning is not known. In a group of young adults with AS, subjective reports of sleep difficulties were supported by PSG data showing increased sleep latency and night waking frequency and lower sleep efficiency.³⁷ PSG also showed increased Stage 1 and 2 sleep, decreased SW sleep, fewer sleep spindles and decreased rapid eye movements in REM in these young adults.³⁷

Types of sleep problems: conclusions

Thus most subjective and objective measurements in sleep studies confirm that insomnia and in particular sleep onset issues are a hallmark of sleep in ASD, though other sleep difficulties including circadian sleep disturbances and parasomnias also occur. Actigraphy and PSG largely confirm subjectively reported sleep difficulties, as well the latter reveals a range of EEG abnormalities or alterations. Parent-report of sleep problems is equally prevalent in autism and AS, but there is some suggestion that there may be differences in the type of problem (e.g., increased parasomnias, daytime sleepiness in AS) or in alterations to sleep EEG that occur. Some lack of consistency, mainly with PSG, may be attributed to one or more of: 1) lack of a control group; 2) small sample sizes (in PSG studies sample size ranges from 1 to 21); 3) within and between sample age ranging from early childhood through to late middle age (mainly in PSG studies); 4) IQ ranging from below 30 to above 80; and 5) both AS and autism diagnoses within the one study group. Despite varied methodologies, sample sizes, control groups, ages and diagnostic ascertainment, as we have documented above, and as Krakowiak et al.¹³ also concluded what is notable

Practice points

1. Insomnia (in particular sleep onset, settling, and night-waking problems) issues are a hallmark of sleep problems in ASD.
2. Objective sleep measures (e.g., actigraphy and PSG) largely confirm subjectively reported sleep difficulties for children with an ASD.

Research agenda

Confirmation of sleep difficulties is required using a combination of subjective and objective measurement methods with more clearly defined groups that:

1. are more homogenous in age
2. meet clear diagnostic criteria for ASD
3. have larger sample size
4. compare children with ASD with other diagnostic groups
5. include separate AS and autism diagnostic groups in the one study.

about studies of sleep in ASD is the consistent confirmation of settling and night waking problems, that is insomnia.

Biopsychosocial factors associated with sleep problems in ASDs

While sleep difficulties are thus common in the ASDs, with sleep onset/settling issues the most consistent and defining problem thus far, what remains unclear is why this is so. An examination of potential precipitating or predisposing factors is best considered from a biopsychosocial viewpoint. Sleep problems may occur as a result of: 1) intrinsic biological or genetic abnormalities that alter brain architecture or biochemistry; 2) psychological or behavioural characteristics connected with core or associated features of ASDs; or 3) factors in the family home or environment, including child rearing practices that are not conducive to good sleep. Any one or combination of these three factors may contribute to sleep problems in the ASDs. Fig. 1 presents a biopsychosocial model of sleep in ASD with two-way arrows indicating potential reciprocal interactions among ASD contributors and symptoms and sleep problems. This complex interaction between biological, psychological and social/environmental factors is an important consideration for investigation and treatment of sleep difficulties in ASD. Following is a discussion of possible aetiological factors for sleep problems in ASD presented within this proposed biopsychosocial framework.

Biological abnormalities

Circadian rhythms and melatonin

Melatonin is a neurohormone whose major role is to organise circadian physiology, particularly the sleep–wake and core body temperature rhythms.⁴¹ It appears to exert its influence on sleep-timing mechanisms via two suprachiasmatic nuclei receptors MT₁, which controls rhythm amplitude and MT₂, which controls rhythm phase.⁴² While the light/dark cycle is the primary zeitgeber (time-giver) that governs the melatonin rhythm, other zeitgebers such as meals and social cues may reinforce this effect.⁴² Sleep problems in children with an ASD may occur due to circadian rhythm dysfunction related to their social/communication difficulties with the result that environmental cues that may act as secondary zeitgebers are not effective because they are either not registered by the child, and/or there may be some intrinsic biological abnormality that causes the child’s nervous system to fluctuate causing faulty transmission of entrainment cues.⁶

Faulty transmission of entrainment cues may be reflected in an abnormal expression of one or more of 10 clock genes that are thought to form the core of the biological clock thus controlling circadian rhythmicity.⁴³ Bourgeron⁴⁴ suggested that clock genes in

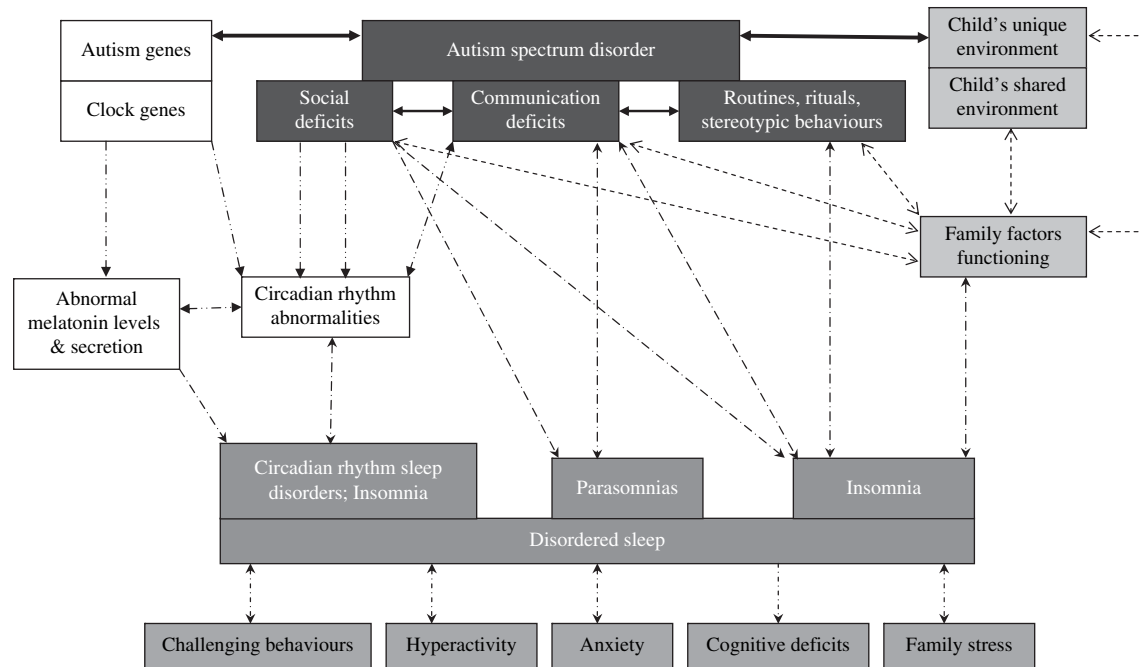


Fig. 1. A biopsychosocial model of common sleep problems and the core behaviours in autism spectrum disorders.

connection with low melatonin and thus circadian timing may be abnormal in autism. He speculated that the circadian sleep problems found in ASDs could be a reflection of genetic abnormalities associated with melatonin synthesis and melatonin's role in modulating synaptic changes. Nicholas et al.⁴⁵ reported an association between specific *Per1* and *NPAS2* clock gene single nucleotide polymorphisms and autism that may be related to reported sleep problems, and both *Per1* and *NPAS2* have been related to the morningness–eveningness phenotype.⁴³ Thus relatively new molecular genetic findings are consistent with the hypothesis that an abnormality in circadian rhythmicity and melatonin secretion may underlie the sleep difficulties in the ASDs. A phase delay in melatonin may result in difficulties with sleep onset, while a reduced amplitude may result in problems with sleep maintenance.⁶ Thus insomnia, late sleep onset and irregular or free-running sleep–wake rhythms in the ASDs indicate that exploration of melatonin in conjunction with sleep is warranted, however few studies have examined melatonin in this population.⁶

The nocturnal, urinary 6-sulphatoxymelatonin excretion rate is reported as depressed in children and adolescents with autism compared with similar age TD children. The effect is marked in pre-pubertal children and is related to autistic severity, but no relationship with “degree of sleep disturbance” was found (p. 137). However the authors speculated that low excretion rate may be related to circadian rhythm dysregulation in autism, including the sleep–wake rhythm.⁴⁶ Most recently examination of the *ASMT* gene that codes for hydroxyindole-O-methyltransferase, the enzyme that converts *N*-acetylserotonin to melatonin revealed two *ASMT* polymorphisms associated with a decrease in *ASMT* transcripts in blood cell lines in ASD.⁴⁷ Consistent with past research, increased platelet serotonin levels and decreased plasma melatonin were found in those with ASD and their parents compared with controls, together with lower *ASMT* activity. A strong association between melatonin concentration and *ASMT* activity occurred in those with ASD. The authors suggested that this identified deficit in melatonin could underlie the sleep difficulties reported in ASD, in particular circadian

Practice points

Preliminary evidence suggests that an abnormality in melatonin production and circadian timing as evidenced by a lower amplitude melatonin rhythm might be causative in both insomnia and circadian sleep disturbances in ASDs.

Research agenda

1. The melatonin rhythm requires investigation.
2. The role of melatonin and clock genes in the expression of the fundamental social-communication and behaviour difficulties and relationships with the sleep problems associated with ASD is an area in need of further exploration.

abnormalities.⁴⁷ These results are consistent with a reduced amplitude melatonin rhythm underlying insomnia in ASD.

Psychological or behavioural characteristics

Psychopathology anxiety and depression

In TD children, insomnia (i.e., increased sleep latency) is associated with anxiety and depression. As those with ASD are particularly vulnerable to psychopathologies, especially anxiety and depression⁴⁸ they may be more vulnerable to sleep difficulties.⁶ In fact, increased levels of anxiety are associated with sleep difficulties in ASD.^{7,16,17} In young adults with AS, it was concluded that a) insomnia was a consequence of high levels of anxiety¹⁷; b) the percentage of time spent in REM is associated with internalising

behaviours on the Child Behavior Checklist (CBCL)⁴⁰ in children with ASD; and c) children with AS and sleep problems are more likely to self-report fears associated with sleeping.¹⁵ Finally, responses to melatonin treatment that improve symptoms of insomnia result in a significant improvement on the internalising subscale of the CBCL in children with AS.⁴⁹

In TD children, depression can be associated with settling difficulties, night waking, early morning waking, and with a decrease in sleep efficiency,⁵ all sleep problems that are commonly reported in the ASDs. Children with autism are vulnerable to depression⁴⁸; and thus, possibly to the sleep disorders associated with it. Research indicates that young adults with AS and insomnia may have a comorbid mood disorder and be generally prone to comorbid psychiatric diagnoses¹⁶; and young children with an ASD and sleep problems are reported to have a higher level of affective problems than those without sleep difficulties.¹¹

Attention Deficit Hyperactivity Disorder (ADHD)

Children with ADHD have high rates of parent-reported sleep problems including settling difficulties, variable sleep patterns, daytime sleepiness, restless sleep, restless legs syndrome, PLMS and sleep apnoea.⁵⁰ These symptoms of insomnia in ADHD closely resemble those commonly reported for the ASDs. While DSM-IV-TR² excludes the diagnosis of ADHD where the primary diagnosis is one of the ASDs, a mounting body of evidence exists suggesting that as many as half of children with ASD also meet current diagnostic criteria for ADHD.⁴⁸

These prevalent hyperactivity, ADHD and oppositional defiant disorder symptoms have been associated with the presence of sleep difficulties in the ASDs.^{28,29,31,51} Parent-reported sleep problems for children with ASD and an ADHD co-diagnosis resemble those reported for children with ADHD rather than those for children with autism or AS and no ADHD co-diagnosis.⁵² Additionally the externalising behaviour scale of the CBCL has been shown to be significantly associated with sleep efficiency in children with AS,⁴⁰ but the attention subscale of the CBCL did not differentiate young good and poor sleepers with ASD.¹¹ Therefore it may be that it is hyperactive behaviour that predisposes children with ASD to sleep difficulties. Thus whatever is unique about sleep problems in ASD may be related to the presence of hyperactivity, rather than to core features of ASD. However this position does not account for those children with ASD who exhibit irregular or free-running sleep patterns as these sleep disorders are not typical of sleep problems reported in ADHD.

Alternatively, in children, symptoms of sleeplessness do not always manifest as daytime sleepiness, but rather as overactivity, which at its extreme may meet criteria for hyperactivity. For example children with sleep apnoea may exhibit classic symptoms of ADHD but when their apnoea is resolved, these behaviours may improve significantly or disappear.⁵⁰ In children with autism parents report that their child is overactive during the day and this daytime overactivity is associated with the presence of sleep problems.⁶ Additionally improvement in the CBCL externalising scale score in response to melatonin treatment for insomnia was reported for children with AS.⁴⁹ Thus in ASD symptoms of insomnia that lead to insufficient sleep may result in behavioural symptoms of ADHD. This may be a causative factor underlying reports that ADHD is frequently a co-morbid condition in the ASDs. It may be that the resolution of sleep problems in ASDs will in many cases resolve ADHD symptoms, but this has not been tested.

Diagnostic features of autism spectrum disorders

Sleep problems in ASD may be related to core or associated features of the disorders, in particular the social-communication

deficits; delayed development; or the presence of epilepsy which co-occurs in about a quarter of children.² Nevertheless this has received scant attention to date. The few studies that have been conducted report a relationship among autism symptoms and sleep problems.

Autism severity. In Schreck et al.'s study, the total hours of sleep per night predicted the overall severity of autistic symptoms on the GARS (Gilliam Autism Rating Scale).²⁴ Children who slept fewer hours had more reported overall autism symptoms.²⁴ In a partial replication⁵³ of the previous study²⁴ total night sleep was correlated significantly with ASD severity, but regression analyses found that more specifically, sleep disordered breathing and parasomnias predominantly predicted the severity of ASD.⁵³ Similarly insomnia in high-functioning ASD is associated with more autism-related symptoms.³¹

Socialisation. Investigation of the relationship between the core features of autism and parent-reported sleep difficulties shows that fewer hours' sleep predict social skills,²⁴ while sleep disordered breathing on the CSHQ predicts GARS social interaction.⁵³ Additionally a 5-year-old with autism and OSA showed improvements in symptoms of autism, including improvements in socialisation after adenotonsillectomy.²⁸ More recently researchers report that poor sleepers with an ASD have higher scores on the reciprocal social interaction scale of the Autism Diagnostic Observation Schedule,¹¹ while high-functioning children with ASD and insomnia have lower parent-reported pro-social behaviour.³¹ This is consistent with the hypothesised link between sleep difficulties and problems in perceiving social cues.

Communication. Communication abnormalities on the GARS predict sensitivity to sleeping environment and waking screaming.²⁴ In a group of children with autism, Fragile-X, ID or who were TD, several PSG parameters are associated with Childhood Autism Rating Scale visual response and non-verbal communication.³⁵

Routines, rituals and stereotypy. One of the core behavioural manifestations shown by children with an ASD is an attachment to routines or rituals, which are often non-functional, but when not able to be fulfilled may result in behaviour problems. Researchers associate these daytime behavioural difficulties with sleep problems.⁶ For example, Schreck et al.²⁴ report that fewer hours of sleep per night predict stereotypic behaviours on the GARS,²⁴ while sleep-disordered breathing on the CSHQ predicts these behaviours in a later study.⁵³ The non-functional routines common in children with ASDs may result in bedtime resistance and settling difficulties and some parents report that so long as the bedtime routine is adhered to, there are no sleep problems.⁶

Development. Developmental regression is often reported in young children who have autism, which is associated with a higher risk of epilepsy.¹⁸ These authors find that regression is associated with both the presence of epilepsy, and the presence of settling and night waking problems and reduced night sleep. Researchers report that comorbid epilepsy predicts daytime sleepiness in ASDs²⁹ and suggest that sleep difficulties in autism might be associated with an increased risk of epilepsy.^{6,54} Developmental abnormalities commonly associated with autism also predict sensitivity to the sleeping environment in one study,²⁴ but in a second study sleep duration and parasomnias predict developmental abnormalities.⁵³

Thus sleep problems are associated with the features of autism but relationships appear inconsistent or non-specific in terms of

the types of sleep problems or the core features of ASDs that may be important. In two papers only a small amount of the variability in symptoms of autism was accounted for by sleep difficulties.^{24,53} Core social-communication deficits may mean that younger or lower functioning children with an ASD do not pick up cues that bedtime is approaching or respond to appropriate bedtime routines, resulting in bedtime resistance. Further many children with an ASD are attached to routines, which when not able to be fulfilled may result in behavioural sleep problems.

Behaviour and cognitive functioning

Behavioural difficulties, poorer cognitive functioning and lowered school performance can be associated with children's sleep difficulties,⁵ while challenging behaviours are common in the ASDs, and may be exacerbated by or exacerbate core features of ASDs.² Thus it is surprising that few studies have investigated the impact of poor sleep on behaviour, cognitive or academic functioning in children with an ASD.

Similar to TD children, poor sleep is associated with the presence of increased disruptive and difficult behaviours in children with an ASD.^{6,31} For example, after treatment a 5-year-old with autism and OSA showed behavioural improvement, moving from the clinical to the normal range on the CBCL,²⁸ while self-injurious behaviour associated with night waking in a 4-year-old with autism reduced markedly with a successful intervention for night waking.⁵⁵ Behavioural improvement as measured by the total CBCL score occurred in children with AS in response to melatonin treatment for severe insomnia,⁴⁹ with improvements found on most subscales. Notably, the more common sleep difficulties reported for children with a DD or autism, particularly bedtime resistance and failure to return to sleep after night-waking (e.g., wandering, playing) can be conceptualised as a class of difficult or challenging behaviours and may respond well to traditional behavioural interventions.²²

Investigation or speculation about the potential impact of sleep difficulties on cognitive functions in the ASDs is scarce. On teacher report, school performance improved after melatonin treatment for insomnia in children with AS.⁴⁹ Further in 10 individuals with ASD it was concluded that waking EEG abnormalities indicated atypical prefrontal activity while REM EEG abnormalities indicated atypical visual cortex activity, supporting information processing difficulties and abnormal visuoperceptual functions.³⁴ PSG studies indicate different sleep patterns in autism compared with TD, ID or Fragile-X children; across all participants, cognitive measures correlated with a number of PSG parameters with the authors concluding that in autism those with "lower perceptual, coordination, or verbal communication skills" (p. 91) have poorer sleep.³⁵ Similarly, in children with AS, IQ is shown to be significantly associated with REM latency and CAP rate.⁴⁰ Thus consistent with reports that poor sleep in TD or ADHD children may be associated with impairments in cognitive function, there are now several studies, albeit with small samples that indicate that impaired cognitive function can be associated with sleep abnormalities in the ASDs.

Family factors

Mothers of TD children with parent-reported sleep problems have high levels of stress, psychopathology and poor sleep.⁵⁶ Children's sleep problems are associated with poorer family functioning including marital discord, poor maternal health, and poor parenting.⁷ Additionally parents of children with DDs report that their child's poor sleep disturbs their sleep and that of other family members.⁵⁷ Thus not only can sleep problems have a negative impact on the child, families may also suffer. Few

researchers consider the impact of sleep problems in ASD on the children's families. Parents of children with autism, PWS, DS or TD children report that while they are concerned about the impact of sleep problems on their child, the impact on other family members and on family well-being is also a concern. Concerns about the impact of sleep on the family are associated with sleep maintenance difficulties.²¹ Sleep problems are reported by 67.9% of 210 Hong Kong families with a young child with ASD and parent stress significantly predicted sleep problem severity.¹²

Biopsychosocial factors and sleep in ASD: conclusions

As our biopsychosocial model of sleep illustrates, factors specific to ASD may underlie many common sleep difficulties; for example, a) the possibility that circadian sleep disturbances are related to clock gene abnormalities, b) the relationship between core features of ASD and sleep problems, or c) the relationship of sleep disorders to psychopathology. But many unanswered questions still exist concerning these relationships. Sleep difficulties also have a negative impact on families and it is likely that this is reciprocal with families that are under stress not being able to maintain strategies that promote good sleep in their child.

Viewing sleep in the ASDs within a biopsychosocial framework has important implications for treatment and prevention. It implies that simply transferring what is known about sleep in TD individuals to the ASD population may be unsuccessful or even counter-productive as the factors precipitating or maintaining the sleep difficulty in the ASDs may be related to atypical rather than typical development. Even where children with ASD meet criteria for Behavioral Insomnia of Childhood, an understanding of the core features of ASD will often be necessary in order to deal with precipitating and maintaining factors. For example, settling issues that are associated with unsuitable bedtime associations or routines, will require an understanding of how these unhelpful bedtime behaviours relate to the core features of ASD in order that appropriate behavioural treatments are devised.

Practice points

1. The influence of sleep problems on day behaviour is largely neglected. Practitioners should consider an evaluation of sleep and sleep problems when assessing and treating daytime behaviour issues for people with an ASD e.g.,
 - a. In individuals with an ASD psychiatric comorbidity, particularly anxiety or mood disorders should be considered when sleep difficulties are a presenting problem.
 - b. If the child presents with hyperactivity, practitioners should investigate sleep and treat any sleep problems.
2. The impact of sleep problems in children with ASD on other family members, particularly mothers, is generally neglected. These families are under high levels of stress related to their child's disorder. The added stress of sleep difficulties potentially has an added negative impact on family functioning and parent psychological wellbeing. Parent psychological wellbeing and sleep needs consideration.

Research agenda

1. Any relationship between the core features of ASDs and sleep problems remains poorly understood and is an area in obvious need of more careful investigation. For example, will treatment of sleep problems alleviate the daytime behaviour difficulties associated with ASDs?
2. The nature and aetiology of sleep difficulties in ASDs should be compared with other populations.
3. The impact of poor sleep on behaviour, cognitive or academic functioning in children with an ASD needs to be systematically investigated.

General conclusion

Sleep problems are common and generally persistent in the ASDs with the majority of children, and possibly young adults with an ASD, likely to experience a sleep difficulty at some time. As the biopsychosocial approach indicates, the aetiology of sleep difficulties in ASD may be multi-factorial, and relates to atypical development found in the ASDs. For example, many of the features of insomnia, particularly settling issues have a strong behavioural component. Epilepsy may also be a contributing factor to sleep disorders for a small but significant proportion of children with an ASD. These sleep difficulties are often a centre of clinical attention over and above the primary ASD diagnosis and are associated with difficult child behaviours and family stress.

With the exception of general frequency of a reported sleep problem and evidence of insomnia, in many instances we are usually relying on a small number of reports to describe sleep in the ASDs. These studies may have design flaws including recruitment strategies, sample sizes, age range, confirmation of ASD diagnosis, lack of separate comparison of autism and AS, and confounding level of developmental delay. Despite these problems, the implication of these research findings is twofold: 1) further research concerning the aetiology of these sleep problems in the ASDs and their relationships with child development, behaviour and psychopathology is required; and 2) practitioners need to take sleep problems in this population seriously as even if only one or two of the associations reported here is proven sleep problems can have potentially serious negative consequences for both the child and their family.

References

1. Fombonne E. The changing epidemiology of autism. *J App Res Intel Disab* 2005;**18**:281–94.
2. American Psychiatric Association. *Diagnostic and statistical manual of mental disorders*. 4th ed. – text revision. Washington, DC: Author; 2000.
3. World Health Organisation. *The ICD-10 classification of mental and behavioural disorders*. Geneva: Author; 1992.
4. American Academy of Sleep Medicine. *International classification of sleep disorders*. 2nd ed.. Westchester IL: Author; 2005.
5. Sheldon SH, Ferber R, Kryger MH, editors. *Principles and practice of pediatric sleep medicine*. Philadelphia, PA: Elsevier Saunders; 2005.
- *6. Richdale A. Sleep disorders in autism and Asperger's syndrome. In: Stores G, Wiggs L, editors. *Sleep disturbances in disorders of development: its significance and management*. London: MacKeith Press; 2001. p. 181–91.
- *7. Wiggs L, Stores G. Sleep patterns and sleep disorders in children with autistic spectrum disorders: insights using parent report and actigraphy. *Dev Med Child Neurol* 2004;**46**:372–80.
8. Allik H, Larsson J-O, Smedje H. Sleep patterns of school-age children with Asperger syndrome or high-functioning autism. *J Autism Dev Disord* 2006;**36**:585–95.
9. Couturier JL, Speechley KN, Steele M, Norman R, Stringer B, Nicolson R. Parental perception of sleep problems in children of normal intelligence with pervasive developmental disorders: prevalence, severity and pattern. *J Am Acad Child Adolesc Psychiatry* 2005;**44**:815–22.
10. Polimeni MA, Richdale AL, Francis AJP. A survey of sleep problems in autism, Asperger's disorder and typically developing children. *J Intellect Disabil Res* 2005;**49**:260–8.
11. Malow BA, Marzec ML, McGrew SG, Wang L, Henderson LM, Stone WL. Characterizing sleep in children with autism spectrum disorders: A multidimensional approach. *Sleep* 2006;**29**:1563–71.
12. Doo S, Wing YK. Sleep problems of children with pervasive developmental disorders: correlation with parental stress. *Dev Med Child Neurol* 2006;**48**:650–5.
- *13. Krakowiak P, Goodlin-Jones B, Hertz-Picciotto I, Croen LA, Hansen RL. Sleep problems in autism spectrum disorders, developmental delays and typical development: a population-based study. *J Sleep Res* 2008;**17**:197–206.
14. Williams PG, Sears LL, Allard A. Sleep problems in children with autism. *J Sleep Res* 2004;**13**:265–8.
- *15. Paavonen EJ, Vehkalahti K, Vanhala R, von Wendt L, Nieminen-von Wendt T, Aronen ET. Sleep in children with Asperger syndrome. *J Autism Dev Dis* 2008;**38**:41–51.
16. Tani P, Lindberg N, Nieminen-von Wendt T, von Wendt L, Alanko L, Appelberg B, et al. Insomnia is a frequent finding in adults with Asperger syndrome. *BMC Psychiatry*:3, Available from <http://www.biomedcentral.com/1471-244X/3/12>, 2003;**12**.
17. Tani P, Lindberg N, Joukamaa M, Nieminen-von Wendt T, von Wendt L, Virkkala J, et al. Sleep in young adults with Asperger's syndrome. *Neuropsychobiology* 2004;**50**:147–52.
18. Giannotti F, Cortesi F, Cerquiglini A, Miraglia D, Vagnoni C, Sebastiani T, et al. An investigation of sleep characteristics, EEG abnormalities and epilepsy in developmentally regressed and non-regressed children with autism. *J Autism Dev Dis* 2008;**38**:1888–97.
19. Hare DJ, Jones S, Evershed K. Objective investigation of the sleep-wake cycle in adults with intellectual disabilities and autistic spectrum disorders. *J Intellect Disabil Res* 2006;**50**:701–10.
20. Goodlin-Jones BL, Sitnick SL, Tang K, Liu J, Anders TF. The children's sleep habits questionnaire in toddlers and pre-school children. *J Dev Behav Pediatr* 2008;**29**:82–8.
- *21. Cotton S, Richdale A. Brief report: parental descriptions of sleep problems in children with autism, Down syndrome, and Prader-Will syndrome. *Res Dev Disabil* 2006;**27**:151–61.
22. Richdale A, Wiggs L. Behavioural approaches to the treatment of sleep problems in children with developmental disorders. What is the state of the art? *Internat J Behav Consult Therapy* 2005;**1**:165–87.
23. Honnichl RD, Goodlin-Jone BL, Burnham M, Gaylor E, Anders TF. Sleep patterns of children with pervasive developmental disorders. *J Autism Dev Dis* 2002;**32**:553–61.
- *24. Schreck KA, Mulick JA, Smith AF. Sleep problems as possible predictors of intensified symptoms of autism. *Res Dev Disabil* 2004;**25**:57–66.
- *25. Schreck KA, Mulick JA. Parental report of sleep problems in children with autism. *J Autism Dev Dis* 2000;**30**:127–35.
26. Segawa M. Circadian rhythm in early infantile autism. *Shinkei Kenkyu No Shinpo* 1985;**29**:140–53 [in Japanese].
27. Takase M, Taira M, Sasaki H. Sleep-wake rhythm of autistic children. *Psychiatry Clin Neurosci* 1998;**52**:181–2.
28. Malow BA, McGrew SG, Harvey M, Henderson LM, Stone WE. Impact of treating sleep apnea in a child with autism spectrum disorder. *Pediatr Neurol* 2006;**34**:325–8.
- *29. Liu X, Hubbard JA, Fabes RA, Adam JB. Sleep disturbances and correlates of children with autism spectrum disorders. *Child Psychiatry Hum Dev* 2006;**37**:179–91.
30. Sadeh A. Commentary: comparing actigraphy and parental report as measures of children's sleep. *J Pediatr Psychol* 2008;**33**:406–7.
31. Allik H, Larsson J-O, Smedje H. Insomnia in school-age children with Asperger syndrome or high-functioning autism. *BMC Psychiatry*:6, Available from <http://www.biomedcentral.com/1471-244X/6/18>, 2006;**18**.
32. Hare DJ, Jones S, Evershed K. A comparative study of circadian rhythm functioning and sleep in people with Asperger syndrome. *Autism* 2006;**10**:565–76.
33. Øyane NMF, Bjorvatn B. Sleep disturbances in adolescents and young adults with autism and Asperger syndrome. *Autism* 2005;**9**:83–94.
34. Daoust A-M, Limoges É, Bolduc C, Mottron L, Godbout R. EEG spectral analysis of wakefulness and REM sleep in high functioning autism spectrum disorders. *Clin Neurophysiol* 2004;**115**:1368–73.
35. Elia M, Ferri R, Musumeci SA, Del Gracco S, Bottitta M, Scuderi C, et al. Sleep in subjects with autistic disorder: a neurophysiological study. *Brain Dev* 2000;**22**:88–92.
36. Godbout R, Bergeron C, Limoges É, Stip E, Mottron L. A laboratory study of sleep in Asperger's syndrome. *Neuroreport* 2000;**11**:127–30.
- *37. Limoges É, Mottron L, Bolduc C, Berthiaume C, Godbout R. Atypical sleep architecture and the autism phenotype. *Brain* 2005;**128**:1049–61.
38. Miano S, Bruni O, Elia M, Trovato A, Smerieri A, Verrillo E, et al. Sleep in children with autistic spectrum disorder: a questionnaire and polysomnographic study. *Sleep Med* 2007;**9**:64–70.
39. Thirumalai SS, Shubin RA, Robinson R. Rapid eye movement sleep behavior disorder in children with autism. *J Child Neurol* 2002;**17**:173–8.

* The most important references are denoted by an asterisk.

40. Bruni O, Ferri R, Vittori E, Novelli L, Vignati M, Porfirio MC, et al. Sleep architecture and NREM alterations in children and adolescents with Asperger syndrome. *Sleep* 2007;**30**:1577–85.
41. Arendt J. Melatonin: characteristics, concerns and prospects. *J Biol Rhythms* 2005;**20**:291–303.
42. Pandi-Perumal SR, Srinivasan V, Spence DW, Cardinali DP. Role of the melatonin system in the control of sleep. *CNS Drugs* 2007;**21**:995–1018.
43. Ebisawa T. Circadian rhythms in the CNS and peripheral clock disorders: human sleep disorders and clock genes. *J Pharm Sci* 2007;**103**:150–4.
44. Bourgeron T. The possible interplay of synaptic and clock genes in autism spectrum disorders. *Cold Spring Harbor Symp Quart Biol* 2007;**LXXII**:1–10.
45. Nicholas B, Rudrasingham V, Nash S, Kirov G, Owen MJ, Wimpory DC. Association of *per1* and *Npas2* with autistic disorder: support for the clock genes/social timing hypothesis. *Mol Psychiatry* 2007;**12**:581–92.
46. Tordjman S, Anderson GM, Pichard N, Charbuy H, Touitou Y. Nocturnal excretion of 6-sulphatoxymelatonin in children and adolescents with autistic disorder. *Biol Psychiatry* 2005;**57**:134–8.
47. Melke J, Botros HG, Chaste P, Betancur C, Nygren G, Anckarsäter H, et al. Abnormal melatonin synthesis in autism spectrum disorders. *Mol Psychiatry* 2008;**13**:90–8.
48. Leyfer OT, Folstein SE, Bacalman S, Davis NO, Dinh E, Morgan J, et al. Comorbid psychiatric disorders in children with autism: interview development and rates of disorders. *J Autism Dev Dis* 2006;**36**:849–61.
49. Paavonen EJ, Nieminen-von Wendt T, Vanhala R, Aronen ET, von Wendt L. Effectiveness of melatonin in the treatment of sleep disturbances in children with Asperger disorder. *J Child Adolesc Psychopharmacol* 2003;**13**:83–95.
50. Owens J. The ADHD and sleep conundrum: a review. *J Dev Behav Pediatr* 2005;**26**:312–22.
- *51. DeVincent CJ, Gadow KD, Delosh D, Geller L. Sleep disturbance and its relation to DSM-IV psychiatric symptoms in preschool-age children with pervasive developmental disorder and community controls. *J Child Neurol* 2007;**22**:161–9.
52. Richdale AL, Polimeni MA, Francis AJP. A comparison of sleep patterns and sleep problems in autism, Asperger's disorder, ADHD, and typically developing children. In: *Paper presented at the International Meeting for Autism Research*. Boston, USA; 2005 May.
53. Hoffman CD, Sweeney DP, Gilliam JE, Apodaca DD, Lopez-Wagner MC, Castillo MM. Sleep problems and symptomology in children with autism. *Focus Autism Other Dev Disabil* 2005;**20**:194–200.
54. Malow BA. Sleep disorders, epilepsy, and autism. *Ment Retard Dev Disabil Res Rev* 2004;**10**:122–5.
55. DeLeon IG, Fisher WW, Marhefka J-M. Decreasing self-injurious behavior with awakening in a child with autism and developmental delays. *Behav Interv* 2004;**19**:111–9.
56. Meltzer LJ, Mindell JA. The relationship between child sleep disturbances and maternal sleep, mood, and parenting stress: a pilot study. *J Fam Psychol* 2007;**21**:67–73.
57. Robinson AM, Richdale AL. Sleep problems in children with an intellectual disability: parental views of treatment, satisfaction and effectiveness. *Child Care Health Dev* 2004;**30**:139–50.



本文献由“学霸图书馆-文献云下载”收集自网络，仅供学习交流使用。

学霸图书馆（www.xuebalib.com）是一个“整合众多图书馆数据库资源，提供一站式文献检索和下载服务”的24小时在线不限IP图书馆。

图书馆致力于便利、促进学习与科研，提供最强文献下载服务。

图书馆导航：

[图书馆首页](#) [文献云下载](#) [图书馆入口](#) [外文数据库大全](#) [疑难文献辅助工具](#)