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Sleep Patterns of Children with Pervasive Developmental Disorders

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Abstract

Data on sleep behavior were gathered on 100 children with pervasive developmental disorders (PDD), ages 2–11 years, using sleep diaries, the Children's Sleep Habits Questionnaire (CSHQ), and the Parenting Events Questionnaire. Two time periods were sampled to assess short-term stability of sleep–wake patterns. Before data collection, slightly more than half of the parents, when queried, reported a sleep problem in their child. Subsequent diary and CSHQ reports confirmed more fragmented sleep in those children who were described by their parents as having a sleep problem compared to those without a designated problem. Interestingly, regardless of parental perception of problematic sleep, all children with PDD exhibited longer sleep onset times and greater fragmentation of sleep than that reported for age-matched community norms. The results demonstrate that sleep problems identified by the parent, as well as fragmentation of sleep patterns obtained from sleep diary and CSHQ data, exist in a significant proportion of children with PPD.

Keywords

Sleep; autism; neurodevelopmental disorder; night waking; behavior

INTRODUCTION

Pervasive developmental disorders (PDD) refer to a group of neurodevelopmental disorders, autism being the best known, that are characterized by a triad of behavioral symptoms: (1) impairment in social interaction, (2) communication deficits, and (3) restricted, repetitive behaviors (American Psychiatric Association, 1994). Although these areas define PDD diagnostically, many other symptoms often coexist, such as a tendency to tantrum, tactile hypersensitivity, self-injurious and destructive behaviors, cognitive impairment, and sleep problems (Johnson, 1996; Rapin & Katzman, 1998).

Whereas all of these behavioral symptoms affect a family, difficulties with sleep may present unique challenges. First, children that sleep poorly at night have been reported as being more likely to exhibit daytime behavior problems (Patzold, Richdale, & Tonge, 1998; Richman, 1981a; Segawa, Katoh, Katoh, & Nomura, 1992). Daytime sleepiness may interfere with the effectiveness of the child's educational and behavioral programs. Second, sleep problems in the child often disrupt the entire family's sleep, potentially leading to added daytime stress and irritability for all family members (Quine, 1991).

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It is important to understand parental concerns about sleep in this population of children, much as has been done in the normally developing population, to provide a framework in which professionals may offer guidance. It has been hypothesized that some of the symptoms peculiar to autism may be directly associated with disturbed sleep (Johnson, 1996; Patzold *et al.* 1998; Richdale, 1999). Segawa *et al.* 1992 noted that improved sleep in a group of children with autism preceded improvement in social relatedness, reduced insistence on sameness, and adaptation to a novel environment. The question of whether sleep patterns are associated with behavioral symptoms or are unrelated remains unanswered.

Increasingly, both research and clinical reports recognize sleep problems as a significant stressor in families of children with PDD (Johnson, 1996; Norton & Drew, 1994). The Treatment and Education of Autistic and Communicatively Handicapped Children (TEACCH) program lists sleep problems as a major behavioral management issue (Van Bourgondien, 1993). Konstantareas and Homatidis (1989) found sleep difficulties to be the most frequently reported management problem of parents of children with autism. Schreck and Mulick (2000) similarly reported that parents of children with autism described more sleep problems in their children than parents of normally developing children or children diagnosed with another disability. In addition to the common concerns of middle-of-the-night awakenings and difficulties in falling asleep, parents of children with autism express fears of their child wandering unsupervised at night (DeMeyer, 1979).

Are the sleep problems of children with PDD more prevalent than the common problems that affect normal infants and young children? Problems of night waking and falling asleep are common in early development. Twenty percent of 1- to 2-year-olds and 14% of 3-year-olds are reported as having such disturbances (Bernal, 1973; Richman, 1981b). By school age, these problems are reported with varying levels of prevalence: bedtime resistance (27%), sleep onset delay (11.3%), night waking (6.5%), and morning wake-up problems (17%) (Blader, Koplewicz, Abikoff, & Foley, 1997). In general, older children who are developing normally have fewer problems than younger children (Richman, 1981a). Age has been inconsistently associated with sleep difficulties in children with PDD. Some studies report sleep as being more problematic in younger than older children with PDD (Inanuma, 1984; Takase, Taira, & Sasaki, 1988). Others have found no age differences, suggesting that problems continue throughout childhood (Patzold *et al.*, 1998; Schreck & Mulick, 2000).

Some of the inconsistencies of past reports are related to methodological issues that make interpretation of results difficult. Studies characteristically have used small samples and varying methods of measuring sleep (e.g., sleep diaries, questionnaire, EEG, actigraphy). Methods and criteria for diagnosing PDD have varied. Few studies have followed children longitudinally, and few have assessed whether a parent's identification of a sleep problem correlated with the child's actual nightly sleep behavior, or how the sleep-wake patterns of children whose parents report a sleep problem differ from those whose parents do not. Some investigators have suggested that parents of children with PDD overreport sleep problems (Hering *et al.*, 1999).

The present study provides data about sleep-wake patterns in a relatively large group of children with PDD. The study attempts to examine whether the sleep-wake patterns of children whose parents report a problem differ from those whose parents report no problem, and how the age of the child may affect the parent's report. Parental report of a global sleep problem is evaluated in relation to two structured instruments, a sleep diary and the Children's Sleep Habits Questionnaire (CSHQ) (Owens, Spirito, & McGuinn, 2000). Although both instruments rely on parent observations, both are structured. Data are systematically quantified and gathered repeatedly over time. Presumably these data are more objective than a single global report of

a sleep problem. Finally, the study assesses whether parents are more stressed in their daily lives when they report their child as having a sleep problem.

METHOD

Participants

The research protocol was approved by the UC Davis Human Subjects Institutional Review Board, and all parents provided informed consent. Participants were recruited through mailings to members of two PDD advocacy groups, one in Northern California and the other in Southern California. The recruitment announcement invited parents to participate in a diary study of sleep habits of children with PDD and encouraged participation regardless of whether the child had problems sleeping or not. No compensation was offered, but results gained from the study were promised to participating parents.

Approximately 1500 announcements were mailed. Enclosed with each mailing was a postage-paid, pre-addressed return postcard. One hundred seventy-five parents responded with a request to learn more about the study. These families were contacted by telephone to explain the project in more detail. Of these 175, 139 agreed to participate following the initial telephone contact. Seventy-eight completed the entire protocol, 22 finished part of the protocol, and 39 did not return any of the forms after the initial telephone interview. Solicitation, recruitment, and retention rates are summarized in Table I.

The introductory phone call gathered social and demographic information, including the child's gender, date of birth, sibling order, household composition, age at diagnosis, and nature of diagnosis. Children were considered appropriate for the study if they were diagnosed with autism spectrum disorder, pervasive developmental disorder—not otherwise specified (PDD-NOS), Asperger's syndrome, or other related disorders. Parents who agreed to participate were asked to mail copies of medical, psychological, and educational evaluations to confirm their child's diagnosis. At the time of the phone call, parents also were asked to globally rate whether or not, in their opinion, their child currently had a sleep problem. The group of 39 children whose parents responded only to the phone call provided social and demographic data and reported affirmatively or negatively to the single global question as to whether or not their child had a sleep problem at the time.

In all, 100 parents of the 139 who initially agreed to participate provided sufficient data about their child's sleep behaviors to be included in data analysis. The final group of 100 (82 males) ranged in age from 2 to 11 years ($M = 5.6$, $SD = 1.80$). The diagnoses of the participating children are listed in Table II.

Procedures

There were two sleep diary data collection periods during the 12-week study as portrayed in Fig. 1: a first period of 1 month (Time-1), followed 6 weeks later by a second period of 2 weeks (Time-2). Two reasons prompted this design. First, a continuous period of daily diary completion over 12 weeks seemed especially arduous for parents already stressed by the demands of caring for a child with PDD. Second, a period of non-collection interspersed between the two collection periods was designed to reduce response bias or "drift to the mean," while increasing the likelihood of independently addressing stability of behaviors over time.

In addition to completing daily sleep diaries, parents were asked to complete two structured questionnaires, the Children's Sleep Habits Questionnaire (CSHQ) (Owens *et al.*, 2000) and the Parenting Events Questionnaire (PE) (Crnic & Greenberg, 1990) on three occasions (see Fig. 1). Questionnaires were administered at the beginning of the Time-1 diary period, at the end of the Time-1 diary period, and at the end of the 12-week study. These periods were selected

to gain baseline data, to assess the reliability of the CSHQ with the sleep diary, to evaluate the effect of parenting stress on sleep, and to assess the stability of the reported behaviors over time.

Measures

Sleep Diary—The sleep diary is a standardized, calendar-style weekly form that asks the parent to note specific sleep-related events on a daily basis: times of sleep onset, awakenings from sleep, subsequent returns to sleep, bedtimes and morning rise times, and times of daytime naps on days when they occurred. Parents were asked to complete the sleep diary for the previous 24-hour period each morning after their child awakened. Completion of the sleep diary typically takes less than 1 min. For the first 4-week block, parents received four weekly forms marked in advance with the appropriate days and dates. Two additional weekly forms were sent before the Time-2 monitoring period. A complete data set consisted of six weekly diary recordings with a 6-week interval separating Time-1 from Time-2.

Children's Sleep Habit Questionnaire (CSHQ)—The CSHQ is a structured parent report that contains 46 items related to common sleep behaviors in children. Parents respond to items on a 3-point Likert scale (rarely = 0–1 night per week; sometimes = 2–4 nights per week; usually = 5–7 nights per week). Eight subscales are derived from these items, with higher scores reflecting greater problems. The subscales include Bedtime Resistance, Sleep Onset Delay, Sleep Duration, Sleep Anxiety, Night Waking, Parasomnias, Sleep Disordered Breathing, and Daytime Sleepiness. Satisfactory test–retest reliability of CSHQ subscales has been reported for both normal and sleep-referred clinical populations ($r = .62-.79$) (Owens *et al.*, 2000).

Parenting Events Questionnaire (PE)—The PE questionnaire is a 20-item self-report instrument that measures frequency and intensity of daily stresses and hassles related to child rearing. The parent is asked to rate how often an event occurs on a 4-point Likert scale (rarely, sometimes, a lot, constantly) and then rate the level of hassle and stress that the event creates for them on a 5-point Likert scale (no hassle = 1, big hassle = 5). The PE provides sub-scores for frequency and intensity of hassles. Both subscores have been shown to have high internal consistency ($\alpha = .85$ and $.90$, respectively) (Crnic & Greenberg, 1990).

Definitions and Data Reduction

The following variables were averaged separately for the Time-1 and Time-2 diary periods. Because of attrition, the first diary period was 4 weeks for 89 children and 2 weeks for 11 children. The data for the 11 children who completed only 2 weeks of Time-1 were not significantly different from the data derived from the 89 children who completed 4 weeks of Time-1 diary collection. Each variable was averaged over the available weeks in the Time-1 diary period. *Sleep latency* represents the time in minutes from when the child was placed in the bed to when the child fell asleep. The *number of awakenings* represents the average number of awakenings for each week of the diary period after sleep onset. The *length of an awakening* represents the average time spent awake per awakening during the week. *Total sleep time* is the average time from sleep onset to the time of morning awakening, minus the amount of time spent awake during the night. *Daytime sleep* represents the average length of daytime naps for the diary period. These sleep–wake behaviors are the customary variables reported in sleep studies. However, they have been averaged over the diary period rather than over 1–2 nights as is customary for laboratory studies of sleep.

The first analysis examined the stability of diary variables from Time 1 to Time 2. For this analysis only the diary variables from the 78 children who had complete diary data for both periods were used. A second set of analyses examined the relationships between the global sleep problem score (yes/no), noted by the parent at the time of the enrollment phone call, and

sleep diary variables and CSHQ and PE questionnaire responses. For these analyses, only Time-1 diary variables were used so that data for all 100 children were available.

RESULTS

At the time of the initial phone call, the most commonly stated reason for nonparticipation was the parents' concern that their child would not benefit directly from the study. There were no other obvious differences in telephone interview responses for the 100 parents who consented to participate and the 39 who did not. There also were no obvious initial interview differences for the 22 families who attrited and the 78 who completed the study. For the 100 families with data at Time-1, 54% claimed a sleep problem in their child at the time of the call. For the 39 who agreed to participate initially but then did not provide any data (Table 1, Early attrition), 56% claimed a sleep problem.

Stability of Sleep-Wake Diary Variables from Time-1 to Time-2

Means and standard deviations for each of the diary variables for Time-1 and Time-2 ($n = 78$) are presented in Table III. The Pearson Product Moment correlation coefficients to assess stability between Time-1 and Time-2 are also listed.

All of the sleep-wake variables were significantly stable from Time-1 to Time-2. In general, children required approximately 30 min to fall asleep once in bed for the night. On average they awakened more than twice a week, with each awakening lasting almost 60 min. They generally averaged 9.5 hr of sleep each night. Because these values were stable across 6 weeks of non-recording, it seems likely that neither parental attribution nor desirability were prominent factors in completing the diaries.

Stability of Questionnaire Variables from Time-1 to Time-2

To assess the stability of the CSHQ and PE questionnaire responses over three administrations, correlation coefficients were computed for each subscale of the CSHQ and each subscore of the PE for the three completion periods. Stability of the eight CSHQ sub-scale scores were significant across time ($r = .556-.837$, all values $p \leq .05$). Stability was also high for the two subscores of the PE questionnaire over the three time periods ($r = .818-.911$, all values $p \leq .01$). Thus a single mean score was computed for each of the eight subscales of the CSHQ and for each of the two PE summary scores.

Parent Report of a Sleep Problem and Diary/CSHQ Sleep Variables

For these analyses, Time-1 data for all 100 subjects were used. Fifty-four of the 100 children were initially reported by their parents as having a sleep problem. Using MANOVA, the diary variables at Time-1 for these 54 children differed significantly from the 46 children whose parents reported no sleep problem. Differences in the lengths of an awakening [<30 min in the nonproblem group vs. >60 min in the problem group; $F(1, 99) = 21.97, p \leq .0001$], in sleep latencies [<30 min vs. >30 min; $F(1, 99) = 7.3, p \leq .01$], and in total sleep times [9.5 hr vs. 9.0 hr; $F(1, 99) = 9.38, p \leq .01$] were significant.

Coefficients of variance were calculated for bedtimes, risetimes, and total sleep times to examine regularity of these variables from night to night, with increasing values reflecting less stability (Gruber, Sadeh, & Raviv, 2000; Taira, Takase & Sasaki, 1988). Daily regularity of rise times [$F(1, 99) = 17.69, p \leq .0001$] and regularity of total sleep times [$F(1, 99) = 14.98, p \leq .0001$] were also significantly different between the problem and nonproblem groups. The sleep problem group was more irregular than the nonproblem group. No significant differences were found in the average amounts of daytime sleep, in the number of awakenings per week, in average bedtimes and rise-times, or in the regularity of bedtimes.

Using MANOVA, responses on the CSHQ indicated that the problem sleep group had significantly higher sub-scale scores for bedtime resistance [$F(1, 99) = 8.18, p \leq .01$], sleep onset delay [$F(1, 99) = 24.11, p \leq .0001$], sleep duration [$F(1, 99) = 48.52, p \leq .0001$], sleep anxiety [$F(1, 99) = 7.49, p \leq .01$], night waking [$F(1, 99) = 7.36, p \leq .01$], and parasomnias [$F(1, 99) = 6.87, p \leq .01$]. Specific questionnaire items that characterized the problem group included heightened restlessness during sleep, night terrors, and the need for a parent to be in the room for sleep onset.

Age and Sleep Problem Status

In an attempt to assess whether parent-perceived sleep problems, diary variables, and questionnaire sub-scale scores were different in older children compared to younger children, two age-groups were defined. The younger group comprised children ages 2–5 years ($n = 45$, $M = 4.1 \pm 0.9$), and the older group comprised children ages 6 years and older ($n = 55$, $M = 7.1 \pm 1.47$). A chi-square analysis of age-group by parent-reported sleep problem yielded a significant result ($\chi^2 = 4.56, p \leq .05$), with older children having more reported sleep problems. A MANOVA for sleep diary variables and CSHQ subscale scores did not demonstrate a significant age-group main effect except for daytime sleep. Younger children exhibited more daytime sleep (naps) than older children [$F(1, 99) = 4.36, p \leq .05$].

Interestingly, the younger and older age-groups did demonstrate significant differences in sleep diary variables when sleep problem status was controlled. That is, using post-hoc, exploratory *t* tests, several significant age differences were found when the children without sleep problems were examined separately from the children with reported problems. As shown in Table IV, among children *without* reported sleep problems, younger children had longer total sleep times [$t(44) = 2.64, p \leq .01$] and earlier average bedtimes [$t(44) = -2.82, p \leq .01$] than older children. These expected age-group differences were not observed in the group of children perceived as having a sleep problem. In addition, among children *with* reported sleep problems, older children took longer to fall asleep at the beginning of the night [$t(52) = -2.04, p \leq .05$], and there was a trend for younger children to awaken more during the night compared to older children [$t(52) = 1.60, p = .11$]. Although these results were not strong, they resemble previous reports of normally developing children suggesting that night waking disturbances are more common among young children and sleep onset disturbances among older children (Wolke, Meyer, Ohrt, & Riegel, 1995).

Sleep Problem Status and Parental Stress and Hassles

As reported earlier, PE questionnaire subscale scores were stable over the three collection periods, so they were averaged. Using MANOVA, parents who stated that their child had a sleep problem reported more frequent daily stresses [$F(1, 99) = 7.42, p \leq .01$] and more intense hassles [$F(1, 99) = 5.27, p \leq .05$] than those who did not report a sleep problem. No significant age-group differences were noted in parents' report of the intensity or frequency of daily stresses.

DISCUSSION

The present study assessed sleep–wake behaviors using a structured sleep diary and the Children's Sleep Habits Questionnaire over a 12-week period. This study is unique in its examination of the short-term stability of sleep–wake patterns in children with PDD. During the initial telephone contact, parents were asked whether or not they perceived their child as having a sleep problem. This initial immediate perception was then used for comparison with their more objective responses to a sleep diary and a structured questionnaire.

Problem sleep, as reported by parents, occurred in over half (54%) of the children with PDD. This percentage is remarkably similar to those previously reported in other studies of children with PDD (Hoshino, Watanabe, Yashima, Kaneko, & Kumashiro, 1984; Inanuma, 1984; Patzold *et al.*, 1998; Richdale & Prior, 1995; Taira *et al.*, 1988). Of particular interest, however, is the finding that all of the children in the current study, regardless of age and parental perception of a sleep problem, took longer to fall asleep and woke more often and for longer periods than reports of normal children of comparable ages (Blader *et al.*, 1997). Similarly, the CSHQ subscale scores for all of the children in this sample were significantly elevated compared to scores published elsewhere for a normal community sample (Owens *et al.*, 2000). In fact, average scores for all of the children in this study more closely resembled the reported scores of children referred to a sleep clinic (Owens *et al.*, 2000). Thus, overall, the current results support previous reports of increased prevalence of disturbed sleep in children with PDD compared to normal age-matched controls (Patzold *et al.*, 1998).

If, in fact, the sleep–wake patterns of this PDD sample resembled more the patterns of a clinical sample referred to a sleep disorders clinic than to a non-referred community sample, why did not more than 54% of the parents report a problem? It is likely that parents of children with PDD have adapted to significant sleep onset and night waking difficulties in their children, especially at the younger ages. Similarly, why do parents of older children report more sleep problems than parents of younger children? Perhaps parents of younger children with PDD believe that the nighttime awakenings are typical for this age-group, and thus they do not view their child as having a sleep problem. Parents of older children may perceive prolonged bedtime routines, difficulties around falling asleep, and very long periods of nighttime awakening as more problematic. Also, perhaps parents of older children with PDD are just more generally exhausted and frustrated.

How representative are the results for the larger community of children with PDD? Even though the study was advertised as a study of typical sleep in children with PDD and sought subjects with and without sleep problems, it is possible that a higher proportion of parents who were concerned that their child might have a sleep problem chose to participate. In favor of the study sample's representativeness is the fact that the prevalence of problem sleep reported by these parents approximates rates previously published for children who were not referred for a sleep problem (Johnson, 1996).

Can the results of this study inform the question of parent bias in overreporting or underreporting sleep problems in children with PDD? Hering *et al.* 1999 noted that parental reports of sleep problems were overstated when compared to actigraphic recordings. Actigraph recordings of children with PDD whose parents reported sleep problems did not show more awakenings than would be expected of normal children without PDD. The authors ascribed the overreporting to parental fatigue.

The results of the current study do not support parental overreporting. Children whose parents reported a sleep problem, in contrast to those who did not, displayed even more difficulty when the more objective CSHQ and sleep diary were used. The CSHQ responses for the entire group, however, resembled CSHQ responses reported for a sleep disordered population of children (Owens *et al.*, 2000). And, because only slightly more than half of the parents in this study reported problems, it appears that the parents as a group tended to underreport rather than overreport. Moreover, because both the sleep diaries and CSHQ subscale scores of perceived problem-sleepers consistently portrayed more delayed sleep onsets and greater sleep fragmentation than nonproblem sleepers, the data support parental accuracy and provide support for the parental perceptions of problem sleep. Nevertheless, because all of the data in this study are ultimately derived from parent reports, to fully evaluate sleep and waking in children with PDD, more objective recording techniques are required.

Might maturational delay of children with PDD be related to their sleep problem? Sleep studies in normally developing children have demonstrated that younger children sleep longer at night than older children (Klackenberg, 1982). This expected maturational milestone did not significantly differentiate the younger from the older children with PDD as a group. Only, as might be expected, an increased amount of daytime napping significantly distinguished the two age-groups. When the problem and nonproblem sleep groups were examined separately, however, age-group differences were noted in the nonproblem group. Maturation may have been derailed in the younger children with a sleep problem who failed to demonstrate longer periods of consolidated sleep. The observation that night waking problems are more common in normal younger children and sleep onset problems in normal older children (Wolke *et al.*, 1995) also was noted in this PDD population.

The greater occurrence of problems surrounding sleep onset in the older age-group also may suggest disorganization of the biological circadian timing system. Children whose diurnal rhythms are not entrained and tend to free run have more difficulty in falling asleep at night (Ferber, 1995). More careful studies that employ biological markers of diurnal organization are needed. It is possible that failures of the circadian timing system may reflect an interaction between environmental experiences and the child's biological clock in the older sleep problem group. Such an effect is suggested by the higher score for the CSHQ item "need for parental presence to fall asleep" in the problem sleep group. It is likely that the parent's decision to be present at sleep onset was designed to ease the transition to sleep for these children.

The nightly role of parents in providing comfort to children with PDD has not been well studied. Consistent bedtime routines have been suggested as playing an important role in how children with PDD settle to sleep (Patzold *et al.*, 1998). Hoshino *et al.* 1984 reported that regularizing bedtime routines led to improved sleep. Good sleep hygiene may be especially important given these children's preference for sameness. Although the children identified as problem sleepers did not differ on questions relating to bedtime routines from nonproblem sleepers, they did differ on questions related to the regularity of their bedtimes. Clearly, more research is needed to understand fully how bedtime routines and circadian mechanisms might interact to affect the sleep onset behaviors of children with PDD.

As might be expected, parents of children with a reported sleep problem also reported more hassles and stress related to parenting than did the parents of children without a reported sleep problem. Although the relationship between stress and sleep problems was significant, the direction of the effect remains unknown. It is possible that sleep problems increase parental stress levels. It is also possible that parents who generally experience the characteristics of PDD in their children as more stressful may contribute to sleep fragmentation as a result of their heightened anxiety. More research is needed to examine the relationship between reported sleep problems and parenting stress in this population.

The results of this study do not support reports in the literature that suggest that older children with PDD have fewer sleep problems than younger children (Inanuma, 1984; Takase *et al.*, 1988). A 3-month time frame is too short to state that children "outgrow" their problem. However, continuity over a 12-week period for sleep-wake variables derived from both daily diaries and CSHQ scores lends credence to parental reports of the chronicity of sleep-wake problems in children with PDD.

In conclusion, the present study reports interesting findings related to sleep habits and sleep problems in children with PDD. The study confirms that parents are accurate reporters of their child's sleep-wake behavior. The data clearly portray fragmented sleep and delayed sleep onsets in all children with PDD compared to reports of normal children of the same age. However, only a little more than half of the sample was described by their parents as having

disturbed sleep. And, indeed, those identified as problem sleepers woke more frequently and for longer periods and had more problems getting to sleep at the beginning of the night than those identified as nonproblem sleepers. Although parent perceptions of a global sleep problem, approximately 2 weeks before the collection of diary and questionnaire data, may have biased their daily diary notations and CSHQ responses during a subsequent 12-week period of study, the quantitative methods are, nevertheless, more objective than a single global impression.

More longitudinal research is needed to clarify the causal mechanisms underlying the more fragmented sleep of children with parentally perceived sleep problems. In addition, more control groups of both normal children and children with non-PDD developmental disorders, matched for age and family size should be studied. The use of objective measures, such as video-somnography and/or actigraphy, beginning at younger ages and continuing over longer periods, should be combined with studies of biological markers of circadian regulation such as cortisol and/or melatonin secretion during sleep.

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*CSHQ = Children's Sleep Habits Questionnaire, PE = Parenting Events Questionnaire

Fig. 1.

Data collection points are portrayed over a 12-week period after an initial phone contact. Sleep diary data are collected for 4 weeks and 2 weeks, respectively. Questionnaires are completed at three points in time.

Table I**Subject Recruitment and Retention**

Type of recruitment/retention	Number of families
Solicitations via mail	1500 members of two advocacy groups
Telephone contact	175/1500 (12% response rate)
Telephone consent	139/175 (79% consent rate)
Immediate attrition	39/139 (28% early attrition rate)
Attrition during study	22/139 (16% late attrition rate)
Completion of study	78/139 (56% completion rate)

Table II

Diagnosis of Participants

Diagnosis	Initially recruited <i>n</i> = 139	Participating sample <i>n</i> = 100
Autism spectrum disorder	92	65
Pervasive developmental disorder—not otherwise specified	28	23
Asperger's syndrome/High-Functioning Autism	14	8
Other (Rett's, Angelman, childhood disintegrative disorder)	5	4

Table III
Stability of Sleep–Wake Variables Over 12 Weeks

Variable (<i>n</i> = 78)	Diary period 1 Mean (SD)	Diary period 2 Mean (SD)	Stability Pearson <i>r</i>
Sleep latency (min)	30 (20)	27 (18)	.789 [*]
Length of an awakening (min)	53 (64)	43 (70)	.447 [*]
Number of awakenings/week	2.46 (3.21)	2.48 (3.25)	.823 [*]
Daytime sleep (min)	13 (26)	11 (29)	.931 [*]
Total sleep time (min)	560 (47)	562 (53)	.840 [*]

^{*}
 $p \leq .01$

Table IV
Sleep Diary Variables, Sleep Problem Status, and Age (Mean and SD)

Variable	No problem			Problem		
	Ages 2–5	Ages 6–11	Total	Ages 2–5	Ages 6–11	Total
<i>n</i>	26	20	46	19	35	54
Sleep latency (min)	24 (14)	22 (13)	23 (13)	27 (17)	40 (24)	35 (23)
Length of awakening (min)	26 (28)	21 (35)	24 (31)	83 (75)	71 (74)	75 (74)
Number of awakenings per week	1.8 (1.6)	1.8 (2.3)	1.8 (1.9)	4.2 (4.9)	2.4 (3.2)	3.0 (4.0)
Daytime sleep (min)	17 (35)	7 (15)	13 (28)	21 (34)	7 (17)	12 (25)
Total sleep time (min)	588 (28)	561 (40)	576 (36)	545 (45)	546 (53)	546 (50)