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Sleep Patterns and Sleep Disruptions in Kindergarten Children

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Assessed sleep patterns and sleep disruptions in kindergarten children and investigated the relation between sleep measures derived from objective and subjective evaluation methods. The sleep patterns of 59 normal kindergarten children (mean age = 5.5 years) were monitored for 4 to 5 consecutive nights by means of activity monitors (actigraph) and by means of parental daily sleep logs. The correlation between the actigraphic measures and the daily parental logs indicated that parents were accurate reporters of sleep schedule measures. However, parents were less accurate in assessing sleep quality measures, significantly underestimating the number of night-wakings and overestimating the quality of their children's sleep. Fragmented sleep was found, by means of activity monitoring, in 41% of the children.

Sleep disruptions are among the most prevalent problems or complaints in clinical settings for children (Ford & Kamerow, 1989; Lavigne et al., 1999). The strong links between sleep problems and psychopathology are manifested in both the clinical diagnostic systems and in clinical research. For instance, the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed. [*DSM–IV*]; American Psychiatric Association, 1994) includes more than 50 manual pages dedicated to sleep disorders, and sleep-related problems are included as symptoms or diagnostic criteria of affective and anxiety disorders. Clinical research has also documented close ties between sleep and behavior problems such as difficult temperament (Fisher & Rinehart, 1990; Owens-Stively et al., 1997; Sadeh, Lavie, & Scher, 1994; Schaefer, 1990; Weissbluth, 1984); attention deficit and hyperactivity disorder (Ball & Koloian, 1995; Corkum, Tannock, & Moldofsky, 1998; Gruber, Sadeh, & Raviv, 2000); anxiety disorders (Blader, Koplewicz, Abikoff, & Foley, 1997; Dollinger, Molina, & Campo Monteiro, 1996; Simonds & Parraga, 1984); and affective disorders (Dahl, 1996; Hill, 1994). Sleep is a very sensitive barometer to psychological stress. Sleep disruptions and sleep alternation in response to stress and trauma have been documented in infants, children, and adolescents (Sadeh, 1996b).

Sleep problems have also been linked to cognitive and learning and developmental difficulties. Children with learning disorders and developmental disorders involving cognitive impairment are more likely to suffer from significant sleep disruptions (Piazza, Fisher, & Kahng, 1996; Quine, 1991, 1992; Wiggs & Stores, 1996a, 1996b). Furthermore, poor academic performance has been linked to poor, insufficient, or disorganized sleep (Epstein, Chillag, & Lavie, 1998; Gozal, 1998; Randazzo, Muehlbach, Schweitzer, & Walsh, 1998; Wolfson & Carskadon, 1998).

The prominent role of sleep in child development and developmental psychopathology underlines the need to establish normative data on sleep patterns and sleep problems during childhood and to further explore the complex bidirectional relations between sleep and behavior. This study is aimed at assessing sleep patterns and sleep problems in kindergarten children using objective and subjective sleep measures.

Prevalence of Children's Sleep Problems

Studies and surveys on childhood sleep problems focus mainly on infancy and early childhood. These studies, which are usually based on parental reports, show that during the first 3 years of life, 20% to 30% of children suffer from sleep disruptions (mainly difficulties falling asleep and maintaining uninterrupted sleep through the night; Anders & Eiben, 1997; Mindell, 1993; Richman, 1987; Sadeh & Anders, 1993; Stores, 1996). Moreover, sleep disturbances during the first years of life tend to persist and may develop into a chronic disorder. For example, Kataria and colleagues (Kataria, Swanson, & Trevathan, 1987) found that 84% of children who suffered from sleep problems in infancy had persistent sleep problems 3 years later. In a different study, 41% of children who were identified as sleep-disturbed at 8 months of age still suffered from sleep prob-

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lems 3 years later. Conversely, only 26% of the children who did not have any sleep problems at the age of 8 months were found to suffer from sleep problems at the age of 3 years (Zuckerman, Stevenson, & Bailey, 1987).

Studies on sleep problems of kindergarten children (ages 4 to 6) are very sparse. This is surprising, considering the unique developmental characteristics of children at this age period. Kindergarten children must adjust to stricter demands of school programs that can affect their sleep–wake schedule. In addition, they are considered vulnerable to fears and anxieties in general and nighttime fears and nightmares, in particular (Muris, Merckelbach, Gadet, & Moulaert, 2000; Muris, Merckelbach, Ollendick, King, & Bogie, 2001). The few studies that do focus on this age group report that sleep difficulties continue to be one of the most prevalent behavioral problems, particularly bedtime resistance. Ottaviano and colleagues (Ottaviano, Giannotti, Cortesi, Bruni, & Ottaviano, 1996) reported that sleep problems (night-wakings and sleep resistance) were found in 14% of 4- to 6-year-olds. Klackenberg (1982) reported that 34% of 4-year-old children woke up regularly during the night, but he concluded that waking up once or several times during the night is not always perceived by the parents as poor sleep at the age of 4 to 5 years. More recently, Pollock (1994) found that 22% of 5-year-old children were reported by their parents to have "mild" sleeping difficulties, and 1.4% reported these problems to be "severe." Several authors have suggested that, whereas night-wakings become less frequent in the late preschool years compared to infancy and early preschool years, the prevalence of bedtime resistance becomes more prominent (Beltramini & Hertzig, 1983; Blader et al., 1997). For example, Beltramini and Hertzig found that 66% of 5-year-old children required more than 30 min to fall asleep, and the bedtime routine of 33% of them was longer than 30 min.

Methodological Issues in Children's Sleep Research

Studies on childhood sleep problems face two main limitations: First, there are no standard criteria or clear definitions for childhood sleep problems, even though sleep problems are amenable to precise quantification. As a result, the criteria used are quite arbitrary, which makes it difficult to compare studies and to reliably assess the prevalence rates of these disorders (Minde et al., 1993; Sadeh & Gruber, 1998; Sadeh, Raviv, & Gruber, 2000). Although consensus exists that the most prevalent problems are night-wakings and difficulties falling asleep, there is no consensus as to questions such as, How many times must a child wake up at night to be diagnosed with a sleep problem? How many nights a week should these night-wakings occur? Different definitions have been proposed for night-waking problems in studies that included kindergarten children among other age groups. For instance, Ottaviano and colleagues (1996) defined a night-waking problem if there were two or more episodes of child arousal during the nighttime, calling parents back multiple times and requiring their presence to resettle, at least four times a week. Beltramini and Hertzig (1983) found that 19% of the parents of 5-year-old children reported that their child woke up at least once every night. Recently, a new classification system has been proposed for diagnosing a sleep disorder in young children (24-month-olds and above). According to this proposal, a sleep disorder is defined by five to seven episodes per week of at least one night-waking per night during the past 3 months (Gaylor, Goodlin-Jones, & Anders, 2001).

Most of the studies that have focused on older children concur that a problem should be defined if the child has three or more night-wakings a week of which a parent is aware (Blader et al., 1997; Kataria et al., 1987; Zuckerman et al., 1987). However, there is no agreement as to the definition of a problematic bedtime struggle, which, according to these studies, is the most common problem. Should this struggle last at least 30 min (Minde et al., 1993; Ottaviano et al., 1996), or more than an hour (Kataria et al., 1987; Zuckerman et al., 1987) for the child to be defined as problematic?

The second shortcoming is that most of the studies rely heavily on subjective reports (parental or self-reports). Studies that compared these reports to more objective methods (activity monitoring) have demonstrated that subjective reports are limited by the restricted and biased knowledge parents have about their children's sleep. More specifically, it has been shown that although parents are reliable reporters of patterns like sleep onset time and duration of sleep, they tend to underestimate variables of sleep quality, such as the number of night-wakings (Sadeh, 1994; Sadeh et al., 2000).

There are a number of objective methods that can be used to study sleep in early childhood. These methods include polysomnography—laboratory or ambulatory multichannel polygraphic recordings (Anders, Emde, & Parmelee, 1971); time-lapse video recordings (Anders & Sostek, 1976); and actigraphy—activity-based monitoring (Sadeh, 1994; Sadeh, Hauri, Kripke, & Lavie, 1995; Sadeh, Lavie, Scher, Tirosh, & Epstein, 1991). Polysomnographic sleep studies provide very detailed sleep information, but they are conducted in conditions that deviate significantly from the child's natural sleep environment, and they are usually limited to only one or two nights. The video recording provides useful and important sleep information, but it requires home installation and quite complex post-monitoring analysis (Sadeh & Gruber, 1998). The third method—actigraphy (activity-based monitoring)—has been established as a valid and reliable method of assessing sleep–wake patterns (Sadeh et al., 1991; Sadeh, Sharkey, & Carskadon, 1994). In contrast to the other objective methods, it enables continuous 24-hr

nonintrusive measurement of sleep–wake and activity patterns, and it does not require special installation (the device is simply attached to the child's wrist or ankle). It provides information on sleep schedule, night-wakings and sleep quality, although sleep disturbances seen in the activity data are difficult to interpret without complementary information (Sadeh & Gruber, 1998).

A recent study that assessed the sleep of elementary school children with actigraphy monitoring found fragmented sleep in 18% of the children. In most of these children, no sleep problem was identified or reported by the parents or the children themselves (Sadeh et al., 2000). These findings stress the importance of evaluating children's sleep with objective methods.

Although there are some studies that used these objective method with infants, the few studies known about sleep in the late preschool years rely solely on parental reports. In light of the important role that sleep plays in child development and psychopathology and the unique opportunity to explore this biobehavioral domain with precise and objective measures, the aim of this study was to investigate the sleep patterns of kindergarten children using actigraphy and parental reports. The main purposes were to evaluate the prevalence of different sleep patterns and sleep disruptions with objective research tools in the child's natural environment and to compare this evaluation to subjective parental reports. Based on earlier findings with infants and toddlers (Sadeh, 1994), our hypothesis was that the prevalence of sleep disruptions assessed by means of actigraphy would be significantly higher than those reported by parents. Furthermore, we hypothesized that parents would estimate more accurately parameters related to sleep schedule (e.g., sleep onset and duration) than measures related to sleep quality (e.g., the number of night-wakings; Minde et al., 1993; Sadeh, 1994; Sadeh et al., 1991).

Method

Participants

Fifty-nine children, 29 boys and 30 girls, participated in the study. They were recruited from three different kindergarten classes. Their ages ranged from 3.8 to 6.1 years (mean age = 5.5 years, *SD* = 0.6). Most of the children belonged to two-parent families of a middle-upper socioeconomic status, with highly educated and employed parents (see Table 1). The National Ministry of Education approved and supported the study. Informed consent was obtained from the parents, and each child was rewarded with a $15 voucher (for an office and school supply store) after completing the study requirements. Consent rates were a bit different for each of the kindergartens: The general consent rate was about 70% (specific consent rates for the three kindergarten classrooms were 47%, 66%, and 91%).

Table 1. *Sample Characteristics*

Variable	Range	*M* ± *SD*
Mother's age	30–49	36.5 ± 4.2
Father's age	31–54	39.8 ± 5.5
Mother's education (years)	10–22	15 ± 2.7
Father's education (years)	10–20	14 ± 2.1
No. of children in family	2–5	2.6 ± 0.8
No. of rooms at home	2–9	4.6 ± 1.5
Birth order	Firstborn—30.5%	Last born—45.8%
Employment (full time)	Fathers—96.5%	Mothers—38.6%
Two-parent families	94.9%	

Because our goal was to assess the full picture of sleep patterns in normal kindergarten children, only narrow exclusion criteria were employed, which led to the exclusion of one boy with asthma problems from the study.

Procedure

Each child received an actigraph device (AMA–32, Ambulatory Monitoring Inc., Ardsley, NY), which monitors the child's body movements during the night. The children's sleep was monitored for four to five consecutive nights. The children were asked to wear the actigraph on their nondominant hand, 1 hr before going to sleep, and to take it off after getting up in the morning. In addition to the objective actigraphy monitoring, parents were requested to complete daily sleep logs.

Measures

Actigraphic raw data were translated to sleep measures using the Actigraphic Scoring Analysis program for an IBM-compatible PC. These sleep–wake measures have been validated against polysomnography with agreement rates for sleep–wake identification higher than 90% (Sadeh et al., 1991; Sadeh, Sharkey et al., 1994).

Actigraphic sleep measures included (a) sleep onset time; (b) morning rising time; (c) total sleep duration (from sleep onset to morning rising time); (d) sleep percent—percent of actual sleep time from total sleep duration excluding wake time after sleep onset; (e) true sleep time—sleep time excluding all periods of wakefulness; and (f) number of night-wakings (lasting at least 5 min). The first three measures were considered as sleep-schedule measures, whereas the last three measures were viewed as sleep quality measures.

The subjective daily information reported by the parents included the following measures: (a) lights-off time; (b) morning rise time; (c) sleep duration (from lights-off to waking-up time); (d) number of night-wakings; (e) sleep quality, rated on a 4-point scale ranging from 0 (*very good*) to 3 (*bad*); (f) duration to fall asleep, rated on a 4-point scale ranging from 0 (*less than 5 min*) to 3 (*more than 30 min*); (g) evening sleepiness, rated on a 3-point scale ranging from 0 (*very alert*) to 2 (*very sleepy*); (h) morning drowsiness, rated on a 3-point scale ranging from 0 (*very alert*) to 2 (*very sleepy*); and (i) sleep duration during the day (Sadeh, 1994; Sadeh et al., 1991).

Results

Prior to addressing the main clinical issues of this study, we first examined key methodological issues related to the recruited sample and the reliability of the measures. These methodological examinations included (a) comparison of sleep measures among kindergarten classes to rule out selective bias between classes and (b) assessment of psychometric qualities of the sleep measures. The statistical tests of developmental and clinical issues included (a) assessment of sleep measures in the total sample, (b) assessment of age and sex-related differences in sleep measures, (c) comparison between actigraphic and reported sleep measures, and (d) identification of children characterized by "poor" sleep quality.

Comparison of Sleep Measures Among Children in Different Kindergarten Classes

Because there were differences in participation rates among the three participating classes, with relatively low consent rates in one of them, analyses of variance were used to assess the possibility of a selective bias in children participating from the three classrooms. No significant differences were found among the kindergarten classes in any of the sleep measures, and therefore all analyses were included in the total sample.

Psychometric Qualities of the Sleep Measures

Raw actigraphic data from four children are illustrated in Figure 1.

To assess the reliability (or stability) of the sleep measures in this age group, reliability estimates for repeated measures (four to five nights) were calculated for each measure (Acebo et al., 1999; Sadeh et al., 2000). The statistic used is reliability estimate for multiple repeated measurements (Winer, 1971). The reliability estimates for the actigraphic measures are represented in Table 2. In general, most of the reliability estimates were found to be adequate (>.70) or better (Acebo et al., 1999).

Each of the measures from the actigraphic and the daily log data was averaged across the four to five nights of monitoring. Means and standard deviations are presented in Table 3.

Developmental and Sex Trends in Sleep Measures

To assess developmental trends, Pearson correlations were calculated between age and the different actigraphic and subjective sleep measures. A significant correlation was found between age and actigraphic sleep onset time ($r = .28$, $p < .05$). Older children tend to fall asleep later than younger ones. As to the subjective measures, a significant negative correlation was found between age and the number of night-wakings. Parents reported more night-wakings in younger children ($r = -.34$, $p < .01$).

No significant sex differences were found for any of the sleep measures.

Correlation Between the Actigraphic Sleep Measures and the Parental Reports

To identify the congruence and discrepancies between reported and objective sleep measures, Pearson correlations were calculated between corresponding measures. The correlation between the subjective and objective measures (see Table 4) revealed relatively high agreement for the parallel sleep schedule measures: Correlations for the sleep onset measure and for the waking-up time measures were both 0.87 ($p < .0005$), and the correlation for sleep duration was 0.81 ($p < .0005$). However, t tests revealed that subjective bedtime was 23.7 min earlier than the actigraphic sleep onset time ($t = 9.1$, $p < .0001$) and the subjective sleep

Table 2. *Actigraphic and Subjective Sleep Measures: Reliability Estimates for Aggregated Values Over 4–5 Successive Nights of Recording*

Sleep Measure	Actigraphic	Subjective
Sleep onset time	.66	.64
Sleep duration	.64	.64
Sleep percent	.79	NA
No. of night-wakings	.71	.72
True sleep	.71	NA

Note: All reliabilities are significant at .0001.

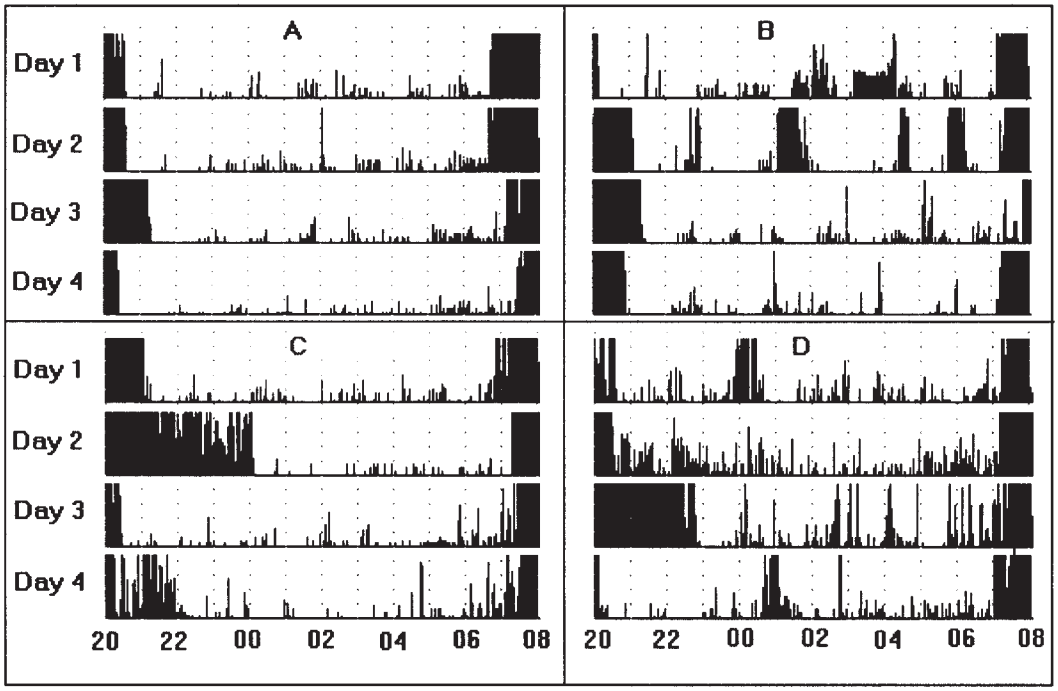

Figure 1. Raw nocturnal activity data of four children (A, B, C, and D). Each panel (A, B, C, D) represents the raw activity data of one child for four consecutive nights. Dark areas represent increased activity level associated with wakefulness (prior to sleep onset, after morning awakening time, and during night-wakings). Children A and C exhibit consolidated sleep with very little activity and no extended or multiple night-wakings, whereas children B and D exhibit fragmented sleep with increased activity throughout the night, identified as multiple and/or prolonged night-wakings. Although his sleep is quite consolidated, child C exhibits significant variability of sleep onset time and sleep duration.

Table 3. *Mean Actigraphic and Subjective (Parental Daily Logs) Measures*

Sleep Measure	Actigraphic *M* ± *SD*	Daily Logs *M* ± *SD*
Sleep onset time	21.44 ± 0.68	21.05 ± 0.66
Morning rising time	6.89 ± 0.37	7.08 ± 0.34
Sleep duration (hr)	9.46 ± 0.71	10.01 ± 0.64
No. of night-wakings	2.66 ± 1.35	0.43 ± 0.45
Sleep percent	91.14 ± 5.1	NA
True sleep (hr)	8.62 ± 0.79	NA
Sleep quality[a]	NA	0.37 ± 0.45
Napping duration (min)	NA	12.70 ± 25.93
Falling asleep duration[b]	NA	0.89 ± 0.59
Evening sleepiness[c]	NA	1.08 ± 0.52
Morning drowsiness[c]	NA	0.39 ± 0.41

[a]0 = very good; 1 = good; 2 = not so good; 3 = bad. [b]0 = less than 5 min; 1 = 5–14 min; 2 = 15–30 min; 3 = more than 30 min. [c]0 = very alert; 1 = a little sleepy; 2 = very sleepy.

duration was 34.2 min longer than the actigraphic sleep duration (t = 10.5, p < .0001).

A significant correlation was also found between the number of actigraphic and subjective night-wakings, r = .42, p < .005 (see Figure 2). However there was a significant difference between the average number of night-wakings according to the subjective evaluation (.45) and the objective measures (2.66), t =13.5, p < .0001.

To better understand the source of the significant discrepancy between actigraphic and parental reports on night-wakings, we calculated the differences between subjective and objective number of night-wakings. The difference score was subjected to step-

Table 4. *Correlations Between Actigraphic and Daily Parental Logs Measures*

Subjective Sleep Measures	Actigraphic Sleep Measures					
	Sleep Onset Time	Morning Rise-Time	Sleep Duration	Sleep Efficiency	Night-Wakings	True Sleep Time
Lights-off time	.87****	.18	–.72****	.04	–.02	–.54****
Morning rise time	.27*	.87****	.20	–.12	.16	.09
Sleep duration	–.73****	.23	.81****	–.13	.17	.56****
Daytime sleep	.49****	–.11	–.51****	–.08	.06	–.44***
Sleep quality	.00	.12	.05	–.28*	.35**	–.12
Sleep latency	.02	.34**	.14	–.43***	.41***	–.17
Night-wakings	–.01	.20	.12	–.44***	.42***	–.20
Evening tiredness	–.09	–.25	–.04	.18	–.18	.09
Morning tiredness	.30*	.21	–.17	–.01	–.06	–.13

*$p < .05$. **$p < .01$. ***$p < .005$. ****$p < .0005$.

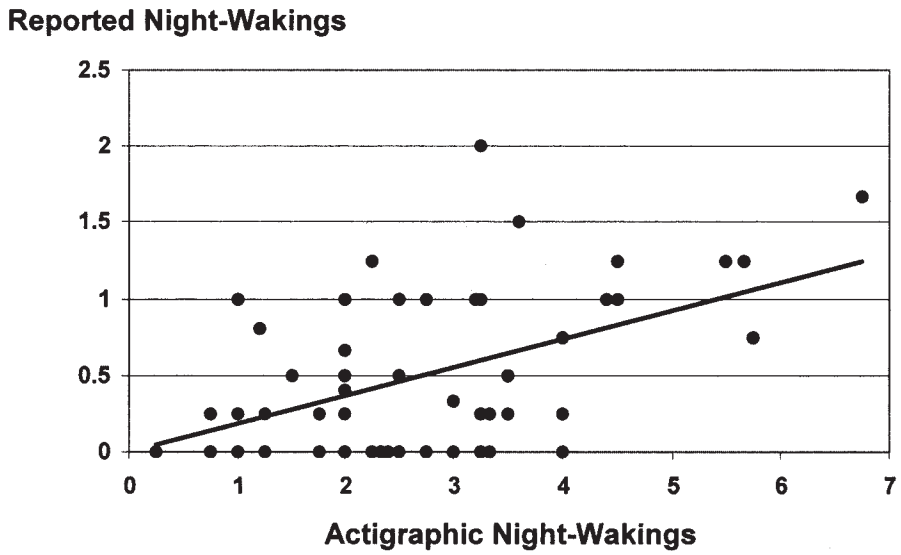

Figure 2. Scatter plot of number of reported night-wakings and number of actigraphic night-wakings.

wise regression analysis with child and parent background variables as predictors. The predictors included parents' age and education level, number of family members, child's birth order, child's sex and age, and the objective sleep measures. The first significant predictor was the number of objective night-wakings; it explained 86% of the variance. Higher number of night-wakings detected by actigraphy was associated with a greater discrepancy between these two measures. The second significant predictor was the age of the child; it explained an additional 2.6% of the variance. Thus, parents of older children who woke up many times according to actigraphy were more likely to underestimate the number of night-wakings in their daily reports. A similar analysis was conducted to understand the discrepancies in reported and actigraphic sleep duration. None of the background variables was found to predict this discrepancy, however.

The subjective measure of the time it took the child to fall asleep was significantly correlated with the objective sleep schedule and sleep quality measures: The longer it took the children to fall asleep, the more night-wakings they had ($r = .41$, $p < .005$) and the lower their sleep percent ($r = –.43$, $p < .005$). The correlation with waking-up time was $r = .34$, $p < .01$.

As expected, the correlation between the subjective quality sleep measure and the objective sleep percent measure was significantly negative ($r = –.28$, $p < .05$), so that the more the child was awake at night, according to the actigraph, the more the parent rated his or her sleep as worst.

Finally, actigraphic sleep onset time was positively correlated with parental assessment of morning drowsiness, $r = .30$, $p < .05$; later sleep onset time was associated with increased morning drowsiness.

Assessment of "Poor Sleep" Prevalence

To identify children with fragmented sleep patterns we defined "poor sleep" as sleep characterized by ei-

ther (a) sleep percent lower than 90% (i.e., the child spent more than 10% of the sleep period, after sleep onset, in wakefulness) or (b) the child waking up three times or more per night on average (each night-waking duration lasting at least 5 min; Sadeh et al., 2000). We used these criteria, which are stricter than those commonly used in the field (Blader et al., 1997; Kataria et al., 1987; Ottaviano et al., 1996; Zuckerman et al., 1987), because the common criteria (which are arbitrary as well) are based solely on parental reports and are not suitable for actigraphic data.

Forty-one percent of the children met the actigraphic night-waking criteria, and 29% of the children had a sleep percent of less than 90%. Therefore, 41% of the children met at least one of the criteria and could be considered poor sleepers according to our criteria.

Applying our night-wakings criterion to the parental daily reports resulted in no identified children. Using a criterion of two or more subjective night-wakings on average also resulted in no identified children. According to these daily reports, 41% of the children woke up at least once a night at least half of the monitored nights, and 18.6% woke up at least once a night on all of the monitored nights. See Table 3 for additional averaged objective and subjective sleep measures.

For comparison, we used the criteria of at least one night-waking every day studied by reports of parents of 5-year-old children (Beltramini & Hertzig, 1983). In our sample, 19% of the children met this criterion (according to their daily sleep logs), which is the exact result reported by Beltramini and Herzig.

Discussion

This study assessed sleep patterns and sleep disruptions in kindergarten children using objective and subjective methods. Because of the limited number of participating children and the fact that these children mostly represent the middle-upper socioeconomic status the interpretation of the data and the generalization of the findings should be considered with caution. In addition, it should be emphasized that although actigraphy has been established as a reliable method to assess sleep–wake patterns, it is solely based on motility patterns and has some limitations and potential artifacts (Sadeh et al., 1995). Furthermore, actigraphy enables identification of sleep disruptions but preclude interpretation of the origins of these disruptions (e.g., diagnosis of specific sleep disorder or medical condition that disrupts sleep).

Before addressing the specific issues of the study, we examine the psychometric characteristics of the measures.

Reliability and Stability of the Sleep Measures

The relatively high (above .70) reliability estimates obtained for the sleep quality measures (e.g., sleep percent, number of night-wakings, true sleep) suggest that these measures are quite stable and reliable. These results are similar to those obtained for younger (12 to 60 months of age) and older children (school-age children and adolescents; Acebo et al., 1999; Sadeh et al., 2000). Reliability estimates obtained for sleep-schedule measures (e.g., sleep onset time, sleep duration) were somewhat lower than .70, reflecting a relative instability of sleep schedule. It should be emphasized that our assessment of stability was limited to school days, whereas other studies have emphasized the dramatic fluctuations between weekdays and weekends as a major source of instability in older children (Wolfson & Carskadon, 1998). It is also important to note that sleep schedule instability has been found as the most prominent feature discriminating between school-age children diagnosed with attention deficit and hyperactivity disorder and their controls (Gruber et al., 2000). These findings suggest that stability measures of sleep–wake system are an important component of other biobehavioral systems, and therefore it is crucial to study sleep for extended periods in natural circumstances beyond the one or two laboratory nights as is often done in pediatric sleep research.

Relationship Between the Daily Logs and Actigraphic Sleep Measures

From the examination of the correlation between the subjective parental daily reports and the objective actigraphic measures, it can be concluded that parents were accurate in their reports with respect to schedule-related measures. This was manifested by the high agreement between the actigraph measures and the parental reports as to sleep onset time, waking-up time, and duration of sleep. These findings are not surprising, because parents are usually involved in their young children's bedtime routine and are awake when their child goes to sleep and when he or she wakes up in the morning. The significant gaps between the subjective and objective sleep onset time and sleep duration reflected the fact that the parents reported about bedtime whereas the actigraph measured the actual sleep onset time.

However, when sleep quality measures were considered (number of night-wakings, sleep quality vs. sleep percent), parents appeared to be poor reporters. Although there was a positive correlation between the number of reported night-wakings and the number of actigraphic-measured night-wakings, parents tended to significantly underestimate the number of their chil-

dren's night-wakings. Specifically, we found that the mean number of night-wakings as monitored by the actigraph was 2.7, but only 0.5 according to parental reports. The positive correlation between the measures indicates that the more the child wakes up, the more the parent is aware of increased night-wakings. However, the difference between the number of night-wakings measured by both methods suggests that parents were far from being aware of many of their children's night-wakings, on average reporting only about one fifth of them.

In general, one may conclude that parents are neither aware of the true number of their children's night-wakings, nor of the amount of time their children are awake during the night. It is probable that most of the children did not signal to their parents when they woke up and that they were able to resume their sleep by themselves, and therefore parents were not aware of their children's night-wakings. The results of the stepwise regression analysis performed to evaluate the factors contributing to the discrepancy revealed it to be higher in older children. This finding supports the idea that older children signal less to their parents, who remain unaware of many of their child's night-wakings. This is also reflected in the parental global assessment of their child's sleep quality. All the parents reported that their children's sleep was good or very good, and no one evaluated it as less than good, compared with the actigraphic measures, which showed that 41% of the children had fragmented sleep. These findings replicate and extend the similar results obtained with both younger and older children in our laboratory (Sadeh, 1994, 1996a; Sadeh et al., 2000).

Another interesting finding concerning the correlation between the subjective and objective measures indicated that the subjective evaluation of the time it took the child to fall asleep was highly correlated to our objective measures of sleep quality. Specifically, it seemed that the longer it took the child to fall asleep (according to the parental report), the more he or she woke up at night, sleep percent was lower, and the child tended to wake up later in the morning. It seems therefore reasonable to conclude that certain sleep problems tend to aggregate and they may represent a wider syndrome of disturbed sleep in children.

Finally, it was found that the later the child went to sleep (according to the actigraph), the more the parents rated him or her as tired in the morning. This is in line with the findings of Sadeh et al. (2000) in school-age children, although they found that not only sleep schedule measures but also sleep quality measures were associated with subjective reports of sleepiness during the day. These findings highlight the links between insufficient sleep and sleepiness in the preschool and school-age period.

Assessment of Sleep Disruptions

One of the main purposes of this study was to estimate the prevalence of sleep disruptions among kindergarten children. As stated previously, there are no established or widely accepted criteria for diagnosing a sleep problem in children. Moreover, the criteria used by different investigators are adjusted for studies relying on parental reports, and there are no known criteria for the diagnosis of sleep problems by means of objective methods, due to the paucity of objective studies. Therefore, in this study we were faced with the problem of deciding what constitutes a sleep problem when measured objectively, and we followed the criteria applied to school-age children in an earlier study (Sadeh et al., 2000). If we had used criteria similar to those used in parental report studies, the results would have been somewhat absurd. For example, in some of these studies (Blader et al., 1997; Kataria et al., 1987; Zuckerman et al., 1987), a prevalence of three night-wakings per week reported by parents is considered problematic. In our study it was found that, according to the actigraphic measurement, all except three of the children woke up at least *once a night* (for more than 5 min). Because this prevalence of night-wakings characterizes almost all the children, it seems unreasonable to use it as a criterion for a sleeping problem. The criteria we chose to use consistently in our studies (i.e., three night-wakings per night on average each lasting at least 5 min and/or a sleep percent value lower than 90%), albeit also somewhat arbitrary, can be considered as more conservative when compared to other studies (high threshold). According to these criteria, this study indicates that 41% of the children, all belonging to a normative, nonreferred sample, could be defined as poor sleepers. This finding raises a crucial clinical and scientific question: Should we be clinically alarmed by this high prevalence of undetected fragmented sleep, or is it a reflection of normal developmental phases and our criteria for a clinically significant problems are inappropriate for this age group? The limited literature does suggest that sleep problems including fragmented sleep are linked to compromised cognitive functioning, emotional dysregulation, and psychopathology in children (Dahl, 1996; Gruber et al., 2000; Randazzo et al., 1998; Sadeh, 1996b; Sadeh & Gruber, 1998). Not many studies have addressed the question of the impact of disturbed sleep on the behavior of children, and further studies need to examine this issue. However, from the many studies conducted on adults, it is well documented that sleep deprivation and sleep disruptions can have significant effects on mood and cognitive functioning (Bonnet, 1994; Orton & Gruzelier, 1989; Smith & Maben, 1993). Considering our findings on high prevalence of sleep fragmentation in kindergarten children, it is important to note that experimental sleep fragmentation studies in adults, in which multiple

night-wakings are induced by external stimuli, have documented significant adverse effects on day functioning (Philip, Stoohs, & Guilleminault, 1994; Roehrs, Merlotti, Petrucelli, Stepanski, & Roth, 1994; Wesensten, Balkin, & Belenky, 1999). Our studies in school-age children, using the same methodology and criteria, have indicated that children with fragmented sleep were less alert during the day and more likely to be rated as presenting more behavior problems and to exhibit poorer performance on computerized neurobehavioral tests of attention and learning (Sadeh, Gruber, & Raviv, in press; Sadeh et al., 2000). These findings suggest that sleep fragmentation, as we define it using actigraphy, is associated with compromised behavioral and cognitive functioning. However, because we have no direct data on the impact or behavioral consequences of fragmented sleep, as defined in our study, the question of how justified it is to define these kindergarten children as sleep-disturbed remains open. The behavioral and developmental consequences of fragmented sleep in this age group should be directly investigated in future research.

The findings of this study are in contrast with the assumption that the prevalence of night-wakings in preschool years declines significantly as compared to infants. Our results appear to be worse than the reported prevalence of sleep problems in infancy, which are in the range of 20% to 30% (Anders & Eiben, 1997; Mindell, 1993; Sadeh & Anders, 1993; Stores, 1996). It should be remembered, however, that these estimates were not based on objective measures. The only relevant comparison is an infant study, which also monitored sleep with actigraphs and found that control babies, who were compared to referred sleep-disturbed babies, woke up on average twice a night (Sadeh et al., 1991). Surprisingly, in this study, the averaged prevalence of night-wakings was even higher than that of the control infants (2.66 night-wakings among the kindergarten children). This finding challenges the assumption that the prevalence of disturbed sleep declines in this age group in comparison to infants. If this finding is supported by future research, it may indicate that, in comparison to infancy, kindergarten children do not necessarily wake up less, but they are more likely to signal less when they wake up and resume their sleep by themselves. In our sample it was found that parents reported more night-wakings in younger children, although no such age-related tendency was found for the actigraphic night-wakings. This is in line with the general conclusion that younger children do not necessarily wake up more often, but they signal more to their parents who then become more aware of these night-wakings.

However, different conclusions could be reached for older children. In a similar study carried out on school-age children, only 18% of the children were identified as poor sleepers (Sadeh et al., 2000). When these two studies are considered, it appears that sleep quality does improve with age and fewer school-age children are identified as poor sleepers in comparison to kindergarten children using the same methods and same criteria. From a developmental perspective, it could be stated that kindergarten children in our sample resemble infants in the prevalence of their night-wakings and schoolchildren in their ability to resume their sleep without signaling to their parents. There may also be a change in the nature of the problems as children mature. In a recent study, as many as 37% of the schoolchildren were identified as having sleep problems in at least one of the evaluated sleep-related behaviors (Owens, Spirito, McGuinn, & Nobile, 2000).

In contrast to the findings derived from actigraphy, the prevalence of parental-reported night-wakings in this study is quite similar to those reported in other parental-based studies. For example, in our study, 19% of the parents reported that the child woke up at least once on all of the monitored nights. This is the exact prevalence reported by Beltramini and Hertzig (1983) for 5-year-old children. In other studies, the prevalence of reported night-wakings (usually referring to at least three to eight night-wakings per week) is between 14% and 34% (Klackenberg, 1982; Ottaviano et al., 1996). These data suggest that when subjective measures are considered, our sample does not appear to be negatively biased, and they therefore underscore the validity of the remarkable results obtained with objective measures.

Clinical Implications

In most clinical settings, the child's sleep assessment is solely based on parental- or self-reports. Our findings suggest that conclusions that are exclusively based on subjective impressions could be misleading. In view of the differences observed between the parental reports and the actigraphic monitoring, it is important to stress that sleep assessment in research as well as in diagnosis and treatment should be carried out, if possible, by complementary objective and subjective evaluation methods. Parental reports continue to be a valuable assessment tool of children's sleep patterns, because they can provide information impossible to obtain from objective methods (e.g., information concerning the subjective parental experiences and the patterns of bedtime interactions). These experiences have been associated with the evolution and persistence of sleep problems in early childhood and therefore are very meaningful, especially in the clinical setting (Adair, Bauchner, Philipp, Levenson, & Zuckerman, 1991; Sadeh & Anders, 1993). However, because parents are poor reporters on the child's sleep quality, it is very important to use complementary objective methods that exist in this field. This is particularly important for clinical re-

search in this area and for clinical cases where a sleep problem is suspected. Having objective and user-friendly measures of clinical problems is a real luxury in our field that could lead to significant improvement in clinical practice and research.

Notwithstanding the crucial question of what the true clinical significance and impact of poor sleep as we defined it is, our findings suggest that children may experience significant sleep disruptions even though their parents and clinicians are not aware of this fact. If sleep problems evade diagnosis and treatment, then the treatment of other comorbid disorders may be compromised. It has been demonstrated, in clinical settings, that the diagnosis and treatment of a sleep disorder may bear positive therapeutic consequences on a comorbid disorder such as attention deficit and hyperactivity disorder (Dahl, Pelham, & Wierson, 1991). The growing awareness for comorbidity of sleep-related problems with other forms of child psychopathology (Ali, Pitson, & Stradling, 1993; Aronen, Paavonen, Fjallberg, Soininen, & Torronen, 2000; Chervin, Dillon, Bassetti, Ganoczy, & Pituch, 1997; Dahl, 1996; Gruber et al., 2000; Lavigne et al., 1999; Liu et al., 2000; Mick, Biederman, Jetton, & Faraone, 2000; Owens, Maxim, Nobile, McGuinn, & Msall, 2000; Owens-Stively et al., 1997; Picchietti, England, Walters, Willis, & Verrico, 1998; Picchietti & Walters, 1999) should alert clinicians to the importance of including a thorough assessment of sleep as an integral part of their clinical diagnostic protocol.

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