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# Early rising children are more active than late risers

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**Background:** A low level of physical activity impacts mental as well as physical health. This study investigated the daily lifestyle habits that affect physical activity in young children.
**Methods:** The relationship between physical activity, assessed by means of a Mini-Mitter Actiwatch device, and observed daily lifestyle habits was analyzed for 204 children, aged 12 to 40 months (average: 22.6 months), for whom 6-consecutive-day data from both the Actiwatch and sleep log were obtained.
**Results:** An older age, male gender, and early waking time showed significant positive correlations with physical activity level. Multiple regression analysis revealed that these three variables were significant predictors of physical activity.
**Conclusion:** Promoting an early rising time is suggested to be an important element of cultivating good health in young children.
**Keywords:** physical activity, children, actigraphy, morning light

A British cohort study of more than 30 years' duration (Viner and Hotopf 2004) has shown that sedentary behavior during childhood also increases the risk of chronic fatigue syndrome/myalgic encephalomyelitis. In contrast, physical activity (PA) decreases the risk of obesity, which is an important risk factor for cardiovascular and metabolic disorders (Haslam and James 2005). Moreover, PA is reported to enhance brain health in general (Cotman and Berchtold 2002). Exercise-derived benefits to brain function have been demonstrated at the molecular level (Berchtold et al 2005), and PA has been reported to decrease the risk for Alzheimer's disease (Friedland et al 2001; Rovio et al 2005). PA is one of the key behavioral activities for promoting healthy brain function in animals, including humans. Thus, identification of the behavioral factors in childhood that increase the performance of PA is important for the promotion of both mental and physical health.

In 1979, 8.1% of children attending day nurseries in Japan were reported as yawning frequently in the morning, and 10.5% as becoming easily tired (Abe 2005). In 2000, these numbers increased remarkably, to 53.2% and 76.6%, respectively (Abe 2005). In accordance with these changes, the reported disturbance of basic daily life habits has progressively been increasing in young children in Japan; the rate of 3-year-old children who went to bed later than 10:00 pm was 22% in 1980, and 52% in 2000 (Kawai 2001). I also reported that the rate of late sleepers whose sleep onset time was 10:00 pm or later was 43.0% among 307 18-month-old infants living in Tokyo, and 53.7% among 151 36-month-old infants living in Tokyo, respectively (Kohyama et al 2000). Moreover, I found 49.6% of 3-year-old children living in a suburb of Tokyo fell asleep at 10:00 pm or later (Kohyama et al 2002). Based on these figures, I hypothesized that the number of inactive children is increasing in Japan, and that the habits of basic daily life influence the activity level of these children. The present

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study was a preparatory one, aiming to establish the effects of daily life habits on PA in young children.

## Methods

Between July 2002 and November 2006, 285 children aged 6–49 months were studied after obtaining written informed consent from their guardians. All of the children were recruited through the Chuo Honcho Public Health Center in the Adachi District of Tokyo, Japan.

Daily PA was assessed using the Mini-Mitter Actiwatch (model AWLP-AM) (AW), a small device (37 × 29 × 11 mm) consisting of an omnidirectional accelerometer sensitive to 0.01 gravity (0.098 m/s$^2$). The information on acceleration is altered into an electrical current that varies in magnitude, and is then stored as activity counts (Minimitter Company Incorporated 1999). The maximum sampling frequency is 32 Hz (Minimitter Company Incorporated 1999; Lopez-Alarcon et al 2004). The daily average activity counts per minute from waking in the morning until falling asleep in the evening [PA (counts/min/day)] were assessed.

According to previous studies (Nishihara et al 2002; Lopez-Alarcon et al 2004; Sulemana et al 2006), the AW device was placed on the ankle of each child for 7 consecutive days, during which period the guardians recorded sleep logs for the children. Times when the AW was removed were also recorded. They were also asked to describe the child's behavior in as much detail as possible during this period. No other special instruction was made for guardians and their children, and they were asked to live their ordinary daily lives. Activity counts and time duration in minutes during the period when the AW was removed (eg, during bathing) as well as the period when nap was taken were omitted from the calculated PA. Times of sleep onset and waking, including napping, were confirmed by matching the records in the sleep logs based on the observation of guardians with the AW data (Benson et al 2004). Since guardians were asked to record the time when their child fell asleep but not the time when the children went to bed, sleep latency could not be measured in the present study.

PA, nap duration on the day when PA was calculated, waking time on the morning of the day, sleep duration of the previous night, and sleep onset time of the previous night were examined. The average values for these measures were calculated for each child, and these average values were used for calculating correlation coefficients. The fluctuation bands for sleep onset and waking times were calculated using the difference between the earliest and latest bedtimes within the recorded period. Correlation coefficients between PA and gender (male: 1, female: 2), age in months, sleep onset time of the previous night, sleep duration of the previous night, waking time in the morning, nap duration during the day, and the bands for sleep onset and waking times were assessed. Correlation coefficients of age in months with sleep onset time of the previous day, sleep duration of the previous night, waking time in the morning, and nap duration during the day were also calculated. Multiple linear regression analysis was used with PA as a dependent variable. The corresponding set of independent variables included age in months, gender, and daily life habits. $p < 0.05$ was considered statistically significant.

## Results

A complete 7-day data set from both the AW and sleep log were obtained for only 22 children. Fifty-nine children yielded data for <5 days. Consequently, 6-consecutive-day data from both the AW and sleep log were obtained from 204 children (103 male and 101 female). The data obtained from these 204 children were used for analysis. Their ages ranged from 12 to 40 months (mean 22.6 ± 7.3 months).

In the sleep logs, most guardians described behaviors of their children in detail. According to these records, I judged that these children lived their ordinary daily lives even during the study period with AW on their ankle.

The average sleep onset time was 21:24 (range: 19:03–24:08, standard deviation [SD]: 49.2 minutes) (Table 1). In 42 children (20.6%), the average sleep onset time was 22:00 or later. The average night sleep duration was 9.9 hours (range: 7.8–14.0, SD: 0.8), waking time was 7:19 (range: 5:05–10:29, SD: 49.8 minutes), nap duration was 1.7 hours (range: 0–3.3, SD: 0.6), the fluctuation band for the sleep onset time was 1.7 hours (range: 0–6.5, SD: 1.2) and that for the waking time was 1.5 hours (range: 0.2–7.0, SD: 0.9), respectively (Table 1).

Among the correlation coefficients calculated (Table 2), significant positive correlations were obtained between older age and PA, as well as sleep onset time and waking time. Significant negative correlations were obtained between waking

**Table 1** Average values for daily life habits

| | Mean value (range) | SD |
|---|---|---|
| Sleep onset time (clock time) | 21:24 (19:03–24:08) | 49.2 min |
| Night sleep duration (h) | 9.9 (7.8–14.0) | 0.8 |
| Waking time (clock time) | 7:19 (5:05–10:29) | 49.8 min |
| Nap duration (h) | 1.7 (0–3.3) | 0.6 |
| Band for sleep onset time (h) | 1.7 (0–6.5) | 1.2 |
| Band for waking time (h) | 1.5 (0.2–7.0) | 0.9 |

**Table 2** Correlation coefficients for the obtained data

| (n = 204) | gender (male: 1, female: 2) | Age in months | Sleep onset time | Sleep duration of the night | Waking time of the day | Nap duration of the day | Band for sleep onset time | Band for waking time |
|---|---|---|---|---|---|---|---|---|
| PA | −0.21** | 0.14* | −0.07 | −0.11 | −0.17* | −0.07 | −0.01 | −0.09 |
| Age in months | nc | nc | 0.17* | 0.05 | 0.21** | −0.29** | 0.10 | −0.03 |

**Notes:** *$p < 0.05$; **$p < 0.01$; nc: not calculated.

time and PA, and between age and nap duration. According to the correlation coefficient between PA and gender, males were found to increase PA significantly. PA also increased significantly with an older age and early waking time. Using 7:30 am as a cut-off time, and comparing PA, the average PA of children who woke up earlier than 7:30 (442.1, SD: 95.7, n = 124) was significantly higher than that of children who woke up at 7:30 am or later (402.9, SD: 96.9, n = 80) ($p < 0.005$).

Based on multiple linear regression analysis, a significantly predictable regression formula was obtained for PA. Significant regression coefficients with respect to PA was obtained for gender (p = 0.006), waking time (p = 0.008), and months of age (p = 0.010).

## Discussion

In this study, daily PA was assessed by means of AW, which has been reported as a valid and useful device for the assessment of PA in children (Puyau et al 2002). In adults, AW is worn on the wrist, but it is also worn on the belt or on the ankle in children and adolescents. Although it is hard to say that ankle activity is fully correlated with overall systematic muscular activity, several papers reported that PA measured by AW on the ankle could be an indicator of PA in infants (Nishihara et al 2002), children (Lopez-Alarcon et al 2004), and in adolescents (Sulemana et al 2006). According to these reports, I placed AW on the ankle, though its adequacy needs to be discussed. None of the children included in this study were too young to walk.

This study determined times of sleep onset and waking including napping by matching the records in the sleep logs with the AW data. Acebo and colleagues (2005) reported the overall similarities between actigraph sleep measures and mother-reported measures, although actigraph-based nocturnal wake minutes were higher than maternal diary reports. Since the present study neglected nocturnal waking, an adequacy of determined data was considered as proper.

This study reveals PA to be significantly correlated with older age and male gender. These results are consistent with our experience that the activity of a child increases with age, and that male children are generally more active than female children. In addition, the present study shows a significant negative correlation between age and nap duration. This finding is also in accord with previous reports (Weissbluth 1995).

In this study, nocturnal sleep and nap duration did not exhibit a significant correlation with PA. If one presumes that adequate rest is indispensable for increasing PA, then children who sleep properly might have better PA. However, our findings did not support this assumption. The required sleep duration for an individual is very difficult to determine because the need for sleep is variable (Carskadon and Dement 2005). One explanation may be that individual requirements for sleep vary, and thus there is no single specific sleep amount that is predictive of PA.

In the preliminary study (Yokomaku and Kohyama 2006), children who had smaller bands for sleep onset and waking times showed lower (= better) scores for some subscales of child behavior check list than those who had larger bands, and the distribution of clinical classification were significantly better for children with smaller band for sleep onset than those who had a larger one. However, in the current study, fluctuation bands for sleep onset and waking times did not affect PA. Effects of regularity of daily life habits on the child's health remain to be discussed.

The current study does, however, show PA to be significantly correlated with earlier waking time, and late risers were found to be more inactive than early risers. PA has so far been discussed as a key behavioral activity for promoting healthy brain function. However, patients with attention-deficit/hyperactivity disorder are known to be pathologically overactive (Simms 2004). In addition, these patients are also widely reported to be poor sleepers (O'Brien et al 2003), and sleep disorders including obstructive sleep apnea syndrome frequently result in behavioral symptoms such as hyperactivity (Simms 2004). Early risers who are sleep-deprived could exhibit pathological daytime over-activity, resulting in the increase of PA. It is hard to rule out this possibility, since the present device for calculating PA does not discriminate between normal and pathological activity. However, with the increasing numbers of children who go to bed late at night and wake up late in the morning (Kawai 2001), there is considerable concern among nursery staffs that the number of children who are exhausted or inactive is increasing (Suzuki et al 2002). A currently obtained result that late risers were more inactive than early risers might be a clue to help these inactive children. But why were late risers more inactive than early risers? One possible explanation could be the involvement of morning light.

Morning light is known to be a powerful cue for shortening the circadian cycle of the biological clock, which is naturally longer than 24 h in most humans (Wever 1979). Consequently, morning light synchronizes the circadian cycle of the biological clock with the 24 h cycle of the earth (Minors et al 1991). Without this time cue, our daily rhythms are apt to act abnormally causing tiredness, impaired alertness and performance, disorientation, gastrointestinal problems, loss of appetite, and inappropriate timing of defecation (Arendt et al 2005). In addition, light exposure in the morning has been reported to be effective for patients with depression (Goel et al 2003; Baghai et al 2006; Jorm et al 2006) and seasonal affective disorder (Terman et al 1989; Terman and Terman 2005; Michalak et al 2007). Lack of exposure to morning light must produce an unfavorable condition for these patients, and might also be so for young late risers in Japan.

However, the current study did not measure the duration and intensity of light exposure for each child. This is a central issue which remains to be determined to test the current hypothesis on the role of morning light. This pilot study has another weakness, which is that no socio-economic or socio-educational data on the families were obtained. These factors could affect both basic daily life habits and PA, and should be assessed in future studies.

The average sleep onset and waking times obtained in the current study, 21:24 and 7:19, respectively, are earlier than those in the previous study from 2002: 21:44 and 7:48, respectively (Kohyama et al 2002). In addition, the rate of children who fell asleep at 22:00 or later was reduced in the current study than in our former studies (Kohyama et al 2000; 2002). A recent nationwide social promotion program to encourage children waking up early in the morning and going to bed early in the night, supported by the Ministry of Education, Culture, Sports, Science and Technology, might have contributed to this differing result. However, the current study also showed a positive significant correlation between age and both sleep onset and waking times. The social promotion of the favorable daily life habits on physical and mental health should be continued.

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# 小児の睡眠関連病態とその治療

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【要 旨】
今、日本の子どもたちは、夜は眠れず、昼は眠い。「不適切な睡眠衛生」に基づく「睡眠不足症候群」と考えるが、治療には難渋する。不眠と眠気の悪循環を、他の要因（朝の受光欠如、夜間の受光、セロトニン活性の低下、メラトニンの分泌抑制等）が助長している可能性を考えている。

◆キーワード
不適切な睡眠衛生
睡眠不足症候群
夜ふかし
朝寝坊
セロトニン

## はじめに

1979年には本邦の保育園に通う児の8・1%が朝からあくびをし、10・5%がすぐに疲れた、と訴えていたが、2000年にはこの数字は、それぞれ53・2%と76・6%に上昇した（子どものからだと心・連絡会議、2005）。

東京都養護教諭研究会の調べによると、2004年東京の小学校5、6年生の男児の5割、女児の6割、中学生では男子の7割、女子の8割が3、4時間目に眠気を訴えている。実はヒトという動物には眠気が強くなる時間帯があり、これは午前4時前後と午後2時前後と言われている。逆に言うと3、4時間目、すなわち午前10～12時という時間帯は、ヒトという動物が本来は最も目が覚めていなくてはいけない時間帯、覚醒度が高くあってしかるべき時間帯である。

また、2006年秋の全国養護教員会の調査[1]でも、「寝不足だと思うか？」との問いに対し、「はい」と答えた割合は、小5で47・3%、中2で60・8%、高2では68・3%に達している。つまり、日本の子どもたちは寝不足で眠気を訴えていることになる。

ただし、注目すべきは寝不足の原因である。2006年秋の全国養護教員会の調査[1]で寝不足と回答した小・中・高校生にその原因を尋ねている（**表1**）が、筆者はこの中で「眠れない」に着目したい。この結果を文字通り受け取ると、子どもたちは眠れず寝不足に陥っていることになる。実際、2003年5月全国の中学・高校240校の10万2451人を対象に行われた調査によると、14・8%が入眠困難を、11・3%が中途覚醒を、5・5%が早朝覚醒を訴え、いずれか一つ以上を呈したものを「不眠」とすると、その割合は23・5%に達している[2]。

## 1．眠れず眠い子どもたち

現在の日本の子どもたちは「夜眠れず、昼間は眠い」ようであるが、では、その原因は何であろうか。International Classification of Sleep Disorders-2（ＩＣＳＤ－2）[3]に従って考えてみる。

「夜眠れず、昼間は眠い」、すなわち眠る時間帯が通常とは異なるのであれば、概日リズム睡眠障害が考えられる。時差型や交替勤務型といった社会生活と密接に関連した病態も含む項目であるが、ここでは比較的頻度が高いと考えられている睡眠相後退型を考える。

**表1　寝不足の原因（2006年 全国養護教員会調査）[1]**

・小学生（720人）
①眠れない（43.8%），②テレビ・ビデオ（39.3%），③勉強（26.3%），④家族の寝る時刻が遅い（22.6%），⑤本・マンガ（21.9%）

・中学生（910人）
①テレビ・ビデオ（44.5%），②勉強（32.2%），③眠れない（31.1%），④本・マンガ（25.9%），⑤電話・メール（23.3%）

・高校生（634人）
①電話・メール（42.4%），②テレビ・ビデオ（38.8%），③眠れない（27.1%），④勉強（23.2%），⑤本・マンガ（20.0%）

その前に、以下の3点を確認しておきたい[4]。

①自律神経、体温、睡眠覚醒リズム、ある種のホルモンリズムは概日リズムを呈するが、そのリズムは脳の視交叉上核に存在する生体時計からの情報に従っている。

②生体時計の周期は大多数のヒトで24時間よりも長く、その周期は朝の受光で短縮し、夜の受光では延長する。

③夜の受光増加と朝の受光減少で、生体時計と地球時刻との同調が損なわれ、概日リズムを呈する様々な生理現象の相互関係が破綻すると、不適切な時期に眠気と不眠が生じ、疲労し、食欲や意欲が低下し、作業能率は低下し、活動量が低下する。

さて、睡眠相後退型[4]では睡眠時間帯は社会通念よりも遅れる。睡眠自体に問題はない。ただし眠る時間帯が社会のリズムとずれているために、社会適応が困難になる場合がある。本症では、朝の光の持つ生体時計の位相の前進作用がうまく働かない可能性が考えられている。また、睡眠不足になると健常者では生じる眠気が生じにくく、早起きをしても早寝が困難であるという[5]。本症には高照度光療法、ビタミン$B_{12}$、メラトニン、時間療法等が試みられる。もちろん睡眠衛生の基本（朝の受光、昼間の活動、夜間の遮光、規則正しい食事）の確認も重要である。

高照度光療法では体温リズムを参考に最低体温直後に光を照射することで、生体時計の位相を早める効果が期待できる。ビタミン$B_{12}$は生体時計の光に対する感受性を高めると考えられているが、保険適用にはなっていない。メラトニンによる入眠時刻の前進効果は、いくつかの報告で一致している[6]が、投与の量やタイミングについては今後も検討が必要である。時間療法は入眠時刻を1日数時間ずつ遅らせて、望ましい時刻に固定しようという方法であるが、単独での長期効果は期待できない。高照度光療法やビタミン$B_{12}$との併用で有効な場合が報告されている[7]。

なお、睡眠相後退型の概日リズム睡眠障害は思春期の発病率が高いとされているが、思春期に顕著になる生活習慣に関連した睡眠相の遅れ（夜ふかし）が混同されて過剰に診断されているとの指摘がある[8]。そして、本症の有症率はせいぜい0・1～0・4％である[9]。リズム障害を病名とするにはそれが第一義的な要因である必要があるが、日本の子どもたちの睡眠時間は最近激減している（**表2**）。彼らに必要な睡眠時間を確保できているとは言い難く、リズム障害を第一義的な要因と断定することは困難である。

次に「不眠」の観点から見る。睡眠呼吸障害、睡眠関連運動異常症は、眠りを阻害し不眠をもたらす可能性がある。新幹線運転手の居眠り事故で有名となった閉塞性睡眠時無呼吸症候群は睡眠呼吸障害の代表で、中年の肥満男性に多い。当然、肥満は発症の危険因子であるが、小児の場合、アデノイド扁桃肥大例のほか、小顎症や顔面中部の形成不全といった顎顔面形態異常、神経筋疾患を含む筋緊張低下が随伴する例、ダウン症児、脳性麻痺、胃食道逆流、重症心身障害児・者、骨系統疾患あるいは早期産児において本症が高頻度で生じる[4]。治療としてはアデノイド扁桃摘除術、持続陽圧呼吸のほ

か、顎顔面形成術10)が行われることがある。ただし、その有症率は2・2〜4・8%である9)。

睡眠関連運動異常症のうちレストレスレッグス症候群や周期性四肢運動異常症で眠りが妨げられることがある4)。

**表2　小・中・高校生の睡眠時間の変化**

| | 小学生（3, 4年） | 小学生（5, 6年） | 中学生 | 高校生 |
|---|---|---|---|---|
| 2006年 | | 8時間24分 | 7時間14分 | 6時間31分 |
| 2004 | 8時間51分 | 8時間46分 | 7時間25分 | 6時間33分 |
| 2000 | | 8時間43分 | 7時間51分 | 6時間54分 |
| 1996 | 9時間 2分 | 8時間51分 | | |
| 1981 | 9時間24分 | 8時間56分 | | |
| 1965 | | 9時間22分 | 8時間37分 | 7時間50分 |

資料：全国養護教員会（2006），中央教育審議会（2004），NHK放送文化研究所（2000, 1965），日本学校保健会（1996, 1981）.

レストレスレッグス症候群（むずむず脚症候群、下肢静止不能症候群）では四肢、特に下肢（中でも膝と足首の間）中心に不快な異常感覚が生じる。この異常感覚は比較的深部に生じ、異常感覚部位を動かすほうが楽になるという。

患者の多くは寝床の中で足を動かし続け、場合によっては立ち上がって歩き回る。具体的な訴えとしては、「足の中が痒い」「足がムズムズする」「誰かに触られている」「足の指の間を芋虫が歩いている感じ」「足がもにゃもにゃする」等がある。表現が稚拙な幼小児や発達障害児（者）の場合、適切な訴えができず、「騒いで寝つかない」と捉えられがちである。ビデオ等を確認することで、下肢を気にしている様子が確認でき、診断のヒントとなる場合もある。また、本症は家族集積性が高い。診断に際しての大切な状況証拠である。

治療では就床前、発作時のマッサージのほか、増悪因子を避けることが重要で、睡眠衛生の基本も確認したい。血清フェリチン50ng／mℓ以下では鉄剤が効果的とされている。難治性の場合にはドーパミンアゴニスト〔pramipexole（6歳で0・125mg）〕が選択される。

睡眠中に四肢、特に下肢に周期的に不随意運動（主として足関節の背屈で、これに第一趾あるいは全趾の背屈、さらには膝関節、股関節の屈曲を伴う場合もある）が反復して生じ、その結果、眠気が阻害された場合に周期性四肢運動異常症と診断される。不随意運動の発生機序は不明で、ドーパミンアゴニストが効果的ではあるが、その作用機序は分かっていない。しばしばレストレスレッグス症候群を合併する。ただし、これらの有症率は、レストレスレッグス症候群で1％、周期性四肢運動異常症で7・1％程度である9)。

睡眠時随伴症も眠りを妨げるが、そのために不眠を来すことは決して多くない。小児では覚醒障害の中の睡眠時遊行症（夢遊病）と睡眠時驚愕症の頻度が高いが、いずれも「寝ぼけ」と認識される。家族集積性は高い。寝入って最初の深い眠りが浅くなる時間帯に起きることが多い。なだめようとすると逆に興奮するので、「周囲から危険なものを除き、必要に応じて施錠等を行い、見守る」ことが対応の基本である。10〜15分で再び寝つくが、翌朝には寝ぼけの記憶はない。頻度が高く家族の負担が大きい場合には、就床前にベンゾジアゼピン系薬剤を投与することもある4)。

最近、覚醒障害と暴力行為との関係について、医学論文や法的な記録から得た31件（患者数）32例（被害者数）〔錯乱性覚醒10例（5例）、睡眠時遊行症10例（5例）、睡眠時驚愕症に引き続く睡眠時遊行症11件12例（5例）。カッコ内は被害者死亡例〕で検討されている11)。その結果、覚醒障害出現中に他人（＝被害者）に対し暴力が振るわれるのは、他人の直接の身体的接触や近接時に生ずる場合が多く、決して無差別、自発的に生じるものではないという。

次に「眠気」の観点からは、中枢性過眠症の代表であるナルコレプシー4)が問題となろう。ナルコレプシーの主徴は①日中の耐え難

い眠気、②強い情動（喜びや驚き）で誘発される脱力発作（カタプレキシー）、③入眠時幻覚、④入眠麻痺、の四つである。入眠直後からレム睡眠に陥り、眠りの持続も悪い。患者の85％以上でHLA class II抗原の特定のハプロタイプ（DQB1*0602かDQA1*0102）が見られるが、孤発例が大半である。小児期発症例の報告も増えている。中核例患者では、覚醒作用、摂食促進作用を有するペプチドであるオレキシンの髄液中の濃度が低下している。死後脳でも視床下部外側野のオレキシン含有細胞の減少が報告されている。

治療としては、中枢神経の刺激にリタリン®、モダフィニル、対脱力発作、対入眠時幻覚・睡眠麻痺に三環系抗うつ薬が用いられるほか、睡眠分断への対応としてベンゾジアゼピン系薬剤を就寝前投与する場合がある。ただし、その頻度は0.03％[9]である。

以上いずれもが、4人に1人の中・高校生が不眠を訴え、5割を超える小・中学生が昼間に眠気を訴えている現状を一義的に説明する病名とは言えない。無論、一義的に説明できなければならないわけではないが、筆者は、現在の日本の子どもたちの大半が該当する病名は、ICSD-2に従えば、「不適切な睡眠衛生」に基づく不眠がもたらす「睡眠不足症候群」ではないかと考えている。

## 2. 不適切な睡眠衛生と睡眠不足症候群[4)12)]

不適切な睡眠衛生は、適切な睡眠衛生［朝の受光、昼間の心身の活動、規則的で適切な食事、夜間の適切な睡眠環境（暗さ、静けさ、温度、湿度）］からの逸脱による不眠であり、カフェインやアルコールも含めた不適切な薬物使用も該当する。

睡眠不足症候群では正常な覚醒状態を維持するために必要な夜間の睡眠を取ることができず、昼間に眠気が生じる。患者自身は慢性の睡眠不足状態にあることを自覚していない。睡眠が十分取れる週末や休暇時には症状が軽快する。

ヒトでは睡眠時間を4～6時間に制限すると脳機能が低下し、約2週間でそのレベルは丸2日間徹夜した時と同程度にまで低下する。急性の睡眠不足は耐糖能を低下させ、交感神経の緊張を高め、インフルエンザワクチンの抗体価上昇を阻害する。慢性の睡眠不足はインスリン抵抗性を高め、2型糖尿病や肥満発症の危険性を高める。

睡眠不足では脳機能も身体機能も意欲も低下し、様々な重大事故も引き起こす。逆に、眠るとひらめきがよくなる。つまり、睡眠不足症候群の症状は攻撃性の高まり、注意・集中力・意欲の低下、疲労、落ち着きのなさ、協調不全、倦怠、食欲不振、胃腸障害などであり、その結果さらに不安や抑うつが生じる場合もある。

「夜眠れず、昼間は眠い」現在の日本の子どもたちを、「不適切な睡眠衛生」に基づく不眠がもたらす「睡眠不足症候群」と診断した場合、治療方針の基本は睡眠衛生の基本を踏まえて、適切な時間帯に適切な睡眠時間を確保すること、に尽きる。ただし、この治療方針が効果をもたらすかと言えば、現実にはきわめて困難である。筆者は、何らかのプラスアルファの要因が不眠と眠気の悪循環を助長しているのではないかと考えている。その要因を考えるに際し、朝型・夜型の行動特性と、その神経学的背景に関心を寄せている。

## 3. 朝型・夜型

### (1) 行動特性

イタリアの6631人の高校生（14～18歳）の調査では、質問紙による検討で742名が夜型、1005名が朝型に分類され、夜型は朝型よりも昼間に眠く、注意力に問題があり、成績が悪く、イライラしやすいことが分かった[13]。米国では、夜ふかし朝寝坊では学力が低下することが報告されている[14]。高知大学からは、夜型傾向の度合いが強まるほど「怒る」と「イライラ」の項目の頻度が増し、中学生では就床時刻が遅くなるほど「落ち込む」と「イライラ」の頻度が高まるという報告[15]がある。

台湾の4～8年生の男子で、夜型の度合いと機嫌の悪さとの相関が高いこと[16]が、フランスの学生では夜型の度合いが高いほど衝動性が高いこと[17]が、また台湾の12、13年生で夜型の学生は朝型や中間型の学生よりも、行動上あるいは感情面での問題点を多く抱え、自

殺企図、薬物依存も多いこと[18]が報告されている。米国の8～13歳児で夜型が、男児では反社会的行動、規則違反、注意に関する問題、行為障害と関連し、女児では攻撃性と関連することも報告されている[19]。筆者らも4～6歳児で睡眠習慣と行動との関係を調べ、就床時刻や起床時刻が早く、かつ規則的であるほど子どもの問題行動が少ないという結果を得た[20]。

夜型は朝型よりも時差ぼけには強い[21]が、夜型や不規則な生活は決してヒトにとって都合のよい生活習慣ではないようである。では、その理由は何であろうか。

**(2) 朝型・夜型の行動特性の背景要因**

a．朝の光のメリット

朝の光は、大多数のヒトにおいて24時間よりも長い生体時計の周期を短縮して、地球時刻に同調させる[22]。朝の受光をせず、この同調作用が発揮されないと、体内で作動している概日リズムを呈する様々な生理現象が同調されずに、それぞれが個別に活動する。同様の状態は時差ぼけ、さらには季節性うつ病[23]や宇宙飛行士[24]でも生じ、意欲低下、覚醒度や作業能率の低下、あるいは状況判断の誤りや胃腸症状等の生理的あるいは知的な面で問題点が生ずる[25]。

また、朝の光は内因性のセロトニン活性を高める[26]。セロトニンは脳内の神経活動の微妙なバランスの維持に重要で、種々の動物実験で、セロトニン系の活性の低下と攻撃性や衝動性の高まり、社会性の低下との関連が指摘されている[27]。攻撃性や衝動性、自殺企図を特徴とする低セロトニン症候群を提唱する研究者もいる[28]。セロトニンの活性が低下すると、気分が滅入り精神的に不安定にもなる。なお、セロトニン系の働きはリズミカルな筋肉運動（歩行、咀嚼、呼吸）によっても高まる[29]。

b．夜の光のデメリット

夜の光は、朝の光とは逆に生体時計の位相を遅延させ[22]、メラトニン分泌を抑制する[30]。抗酸化作用を有するメラトニンには眠気をもたらす作用もある[4]。成熟マウスを恒常的な明環境に置くと、視交叉上核の神経細胞個々のリズム形成能は失われないものの、神経細胞同士のリズムの同調が困難となる[31]。さらに、夜間の受光は生体時計の機能を停止させる[32]。

c．夜型では

「夜ふかし朝寝坊」すなわち夜型は、時差ぼけ状態をもたらし、運動量の低下と肥満を招く。その結果セロトニン系の活性が高まらず、イライラ感、攻撃性の増加等感情制御の問題が生じる。運動量が減ると、睡眠不足とも相俟って知的な機能も低下する。さらに「夜ふかし」は、運動不足、睡眠不足、メラトニン分泌低下、肥満とも相俟って、様々な生活習慣病をもたらす（**図1**）。

筆者は、現在の日本の子どもたちが陥っている不眠と眠気の悪循環を助長する要因に、朝の受光の欠如、夜間の受光、セロトニン活性の低下、メラトニンの分泌抑制等が関わっているのではないかと想像している。近縁の疾患名としては起立性調節障害、慢性疲労症候群、抑うつ状態、線維性筋痛症なども挙げられるであろう[12][33]。

## 4．治療

治療としては睡眠衛生の基本の確認が第一義であろうが、近縁疾患を考慮すると、従来から行われている治療法〔光療法、時間療法、運動、薬物（睡眠導入薬、抗うつ薬、メラトニン、ビタミン$B_{12}$）、認知行動療法、代替療法（漢方、自律神経鍛錬、呼吸法等）〕も積極的に取り入れ、総合的に対応する必要があるのではないかと考えている[33]。もちろん、睡眠衛生に関する社会的な啓発運動も重要である。

## おわりに

表1で小・中・高校生が寝不足の原因として「眠れない」を挙げていることを紹介した。この語句をそのまま捉え、最近しばしば聞くのが「睡眠障害の増加」という指摘である。しかし、昼間は身体を動かさず、夜はいつまでも明るいディスプレイの前で過ごしていては、身体は疲れず、メラトニン分泌は抑制され、生体時計の位相は遅れ、生体時計の機能は停止し、夜になったからといって眠れないのは当然である。ヒトという動物の生理を考えれば至極当然の生理現象の結果の、不適切な睡眠衛生に基づく「眠れない」なのである。

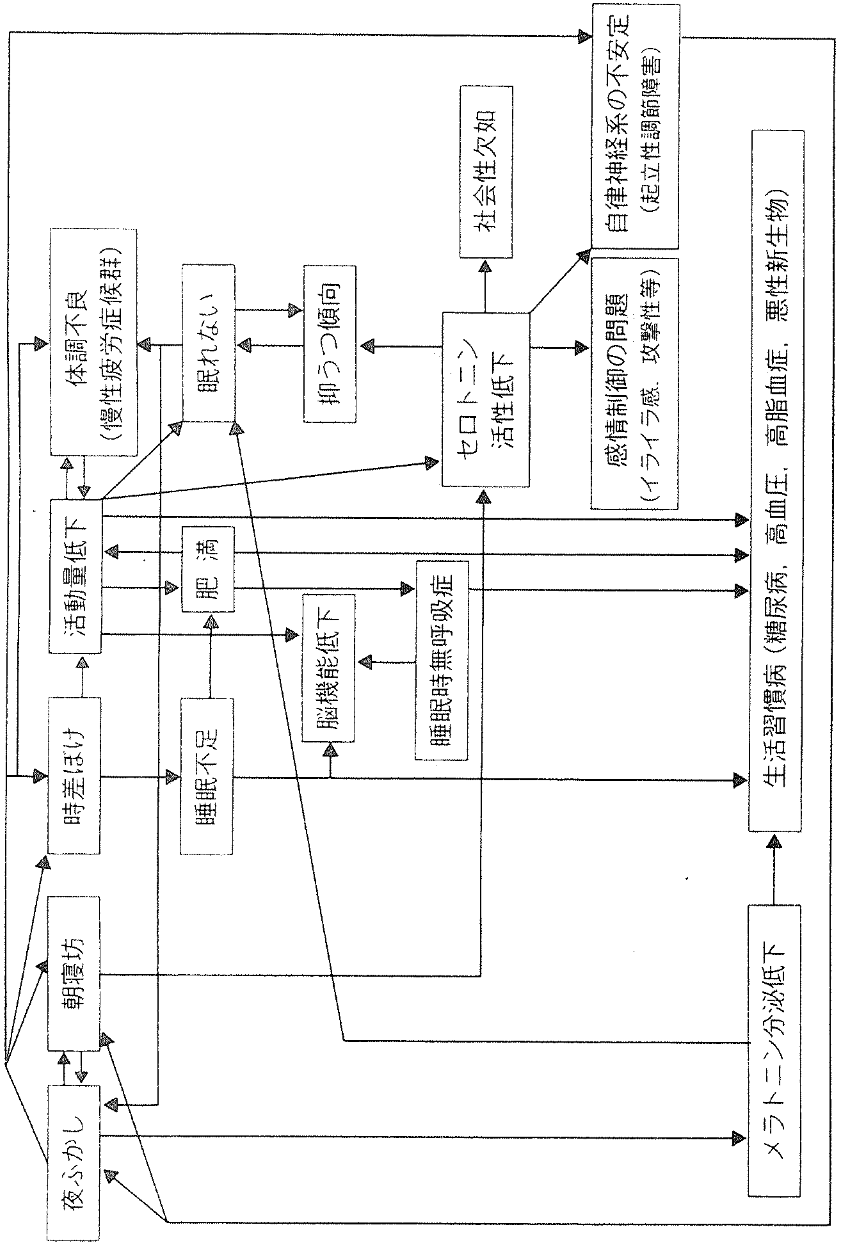


**図1　夜ふかし朝寝坊がもたらす心身の諸問題**

しかし現実には、このようないわば生理的な、当然生じるべくして起こっている不眠も、しばしば「睡眠障害」と判断され、薬物投与すら行われている。消化不良で下痢をしているにもかかわらず飽食し、下痢が止まらない時に下痢止めを処方するようなものである。しかも、薬物投与が必ずしも効を奏さない「眠れない」なのである。そこで本稿を起稿した。何が本質なのか、今後も見極める努力を続けたい。

## 文　献

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# A STUDY OF THE ASSOCIATION BETWEEN SLEEP HABITS AND PROBLEMATIC BEHAVIORS IN PRESCHOOL CHILDREN

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This preliminary study examined the association between sleep habits and problematic behaviors in healthy preschool children using an internationally standardized method. Two groups of 4–6-yr-old healthy Japanese children were recruited. Children in Group A (n = 68) met one or more of the following three conditions: they went out from their home with adults after 21:00 h two or more times a week, they went to bed after 23:00 h four or more times a week, and they returned home after 21:00 h three or more times a week, while those in Group B (n = 67) met none of these conditions. Sleep-wake logs and the Child Behavior Checklist (CBCL)/4–18 were completed daily for two weeks. The CBCL consists of questions with 113 items categorized into eight subscale items: (I) Withdrawn, (II) Somatic complaints, (III) Anxious/depressed, (IV) Social problems, (V) Thought problems, (VI) Attention problems, (VII) Delinquent behavior, and (VIII) Aggressive behavior. Internalizing (I + II + III), externalizing (VII + VIII), and total scale scores were also derived. Generally, the higher the score, the greater the likelihood of problematic behaviors in that scale. We compared both the CBCL scores and distribution of the CBCL score-determined clinical classification of behavior (normal, borderline, and abnormal) between the groups. Correlation coefficients between CBCL scores and each of the seven indices of the studied sleep habits (wake-up times, bedtimes, nocturnal sleep duration, nap duration, total sleep duration, and range of variation in wake-up and bedtime) were also assessed. Group A children showed significantly shorter average nocturnal sleep, nap, and total sleep duration, significantly later average bedtimes and wake-up times, and a significantly greater range of variation in bedtimes and wake-up times than Group B children. The CBCL score of the total scale was significantly higher in Group A than Group B children. The distribution of the clinical classifications of behavior between the two groups showed no significant differences.

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Although nocturnal sleep, nap, and total sleep duration did not correlate with total CBCL score, it showed a high positive correlation with wake-up times, bedtimes, and ranges of variation in both wake-up and bed times. The distribution of the clinical classification for the total scale showed significant differences between early and late risers, and also between regular and irregular sleepers. The number of children classified as normal for the total scale score was higher in early risers and regular sleepers than in late risers and irregular sleepers. Preschool children of Group A, late risers, late sleepers, irregular risers, and irregular sleepers were likely to show problematic behaviors. (Author correspondence: j-kohyama@tokyokita-jadecom.jp)

**Keywords** Sleep-wake rhythm, Child Behavior Checklist (CBCL), Biological clock, Morningness, Eveningness

## INTRODUCTION

Nocturnal lifestyles among children have become progressively more common in Japan recently. The proportion of three-year-old children going to bed after 22:00 h was ~20% in 1980 but exceeded 50% in 2000 (The Japanese Society of Child Health, 2000). Bedtime delay in youngsters reduces total daily sleep duration (Kohyama et al., 2002), and ~80% of kindergarten and nursery school teachers reported that many children are sleep-deprived (Suzuki et al., 2002). Sleep deprivation has a negative effect on daytime functioning (Randazzo et al., 1998; Teixeira et al., 2007; Wolfson & Carskadon, 1998), general well-being (Ohayon & Vecchierini, 2005), metabolic and endocrine function (Spiegel et al., 1999; 2005), and body weight (Taheri, 2006).

Not only sleep shortage but also delayed bedtimes and wake-up times are known to produce health problems. Later bedtimes and wake-times have been found to be significantly associated with sub-clinical manic-type symptoms among working adults (Soehner et al., 2007), and evening- as compared to morning-type medical school students have been reported to have lower sleep efficiency (Lehnkering & Siegmund, 2007). An association between evening type and mood and anxiety symptoms was reported in young adolescents in Taiwan (Gau et al., 2004). Gaina et al. (2006) reported that Japanese junior high school pupils who showed an evening preference were more likely to have poorer sleep-wake parameters and lifestyle habits than those who showed a morning preference. Caci et al. (2005) reported an association between eveningness and impulsivity in students, and Gau et al. (2007) reported that evening-type 12–13-yr-old students were more likely to have behavioral/emotional problems, suicidality, and habitual substance use than morning type ones. Susman et al. (2007) concluded that eveningness is related to antisocial behavior and rule-breaking and attention behavior problems, as well as conduct disorder symptoms in boys and relational aggression in girls among children aged 8 to 13 yrs. An irregular lifestyle has also been known to be associated with delayed bedtimes and wake-up times. In college students, there was less regularity of social rhythms in poor relative to good sleepers, and later rise and bed times were reported to be associated with worse sleep (Carney et al., 2006). In adults, evening types have been reported to be more irregular in their daily lifestyles than morning types (Monk et al., 2004). Taken together, these reports suggest the association of the evening type (delayed wake-up times, delayed bedtimes, and even an irregular lifestyle) with problematic behaviors of older children, adolescents, and adults. But what are the neuronal mechanisms underlying this association?

According to Kerkhof and Van Dongen (1996), the endogenous phasing of the circadian clock of morning types differs from that of evening types. The endogenous period of the circadian clock of most people is longer than 24 h, and through exposure to sunlight in the morning, people are entrained to the Earth's 24 h cycle (Minors et al., 1991). By the age of three months, the circadian sleep-wakefulness rhythm is stabilized (Cornwell & Feigenbaum, 2006). Conversely, light exposure at night delays the phase of the circadian clock (Minors et al., 1991) or disrupts its function (Ukai et al., 2007). Non-photic cues, such as feeding (Mieda et al., 2006) and activity (Waterhouse et al., 2007), also serve to synchronize the circadian system to the 24 h day. In the absence of such time cues, our daily rhythms are apt to run freely. After spending life under free-running conditions for a considerable period of time, the staging of various biological rhythms, such as sleep-wakefulness and temperature, are known to become altered (Wever, 1979). Under such conditions, the reciprocal phase interactions among the circadian rhythms are disturbed. In general, most people spontaneously wake up in the morning when the body temperature begins to rise from its lowest level, and are able to fall asleep in the evening when the body temperature begins it decline from its highest level. However, once the reciprocal interaction is impaired, the phase relationship between the body temperature and sleep-wake circadian rhythms is disrupted (Wever, 1979). This condition, which is known as circadian desynchronization (Katz et al., 2001; Rivkees, 2001), can occur as a result of jet lag, resulting in various physical and mood disturbances (Arendt et al., 2005). Similar complaints and mood alteration are observed in patients with seasonal affective disorder (Terman & Terman, 2005) and in astronauts (Mallis & DeRoshia, 2005).

Few studies have assessed the role of circadian desynchronization on the behavior of youngsters. It is of significant concern that the current deteriorating sleep habits of younger children might have unfavorable effects on their behaviors. An association between sleep problems and problematic behaviors in certain medical conditions has been previously described; children with autism or attention-deficit hyperactivity disorder (ADHD) are known to have sleep problems (O'Brien et al., 2003; Richdale, 2001). In addition, many behavioral problems have been reported in children with sleep apnea (Kohyama et al., 2003; Mitchell & Kelly, 2006). Interview surveys conducted among care-givers of 111 essentially healthy 2-yr-old nursery school children without obvious disorders revealed that most children with irregular sleep-wake rhythms exhibit developmental and behavioral problems, such as aggressiveness, stubbornness, and blank expressions (Suzuki et al., 2003). A report on 348 5-yr-old kindergarten and nursery school children suggested that the more irregular the sleep-wake rhythm of the child, the greater the tendency for problematic behaviors (Suzuki et al., 2005). However, the assessment of child behavior in these studies was essentially descriptive. Indeed, the greatest deviation of attention was found in preschool children (Janvier et al., 2007), indicating the difficulty in assessing their behaviors. This methodological limitation might be one of reasons why few studies have addressed the association between various aspects of sleep habits and the behaviors of preschool children.

The purpose of the current study was to examine the association between various aspects of sleep habits and behavior of healthy preschool children. We used an international standardized method, a child behavior checklist (CBCL), to evaluate behavioral problems in children (Achenbach, 1991). By using this standardized method, we sought to overcome the difficulty of assessing the marked deviations of attention in preschool children, as reported by Janvier et al. (2007). Recently, it was reported that Japanese children in daycare nurseries showed later bedtimes, earlier wake-up times, and shorter total night sleep time than children in kindergarten (Benesse Corporation, 2005). Thus, in the present study, we allotted an equal number of kindergarten and nursery school children to each of our study groups, as the purpose of this study was to examine the association between sleep habits and behaviors of presumably healthy preschool children, keeping in mind the children we judged to be healthy at the onset of the study could actually be reclassified later as abnormal in their behavior based on the data and clinical categories of the CBCL.

## MATERIALS AND METHODS

### Participants

We recruited a total of 140 Japanese children of both genders, 4–6 yrs of age, from the Tokyo metropolitan area and its suburbs who met the conditions outlined below. The recruitment of subjects was undertaken by 22 professional researchers from a private market research company. Although none of the researchers were medical doctors or psychologists, they had sufficient experience in the recruitment of subjects by means of direct visiting. Children in group A were required to meet one or more of the following three conditions:

1. they went out with adults after 21:00 h two or more times a week;
2. they went to bed after 23:00 h four or more times a week; and
3. they returned home after 21:00 h three or more times a week.

Those in group B were required to meet none of these conditions. We selected these three criteria to form the two study groups based on the recently documented increasing nocturnal lifestyles among Japanese children (The Japanese Society of Child Health, 2000).

Non-probability sampling was applied to make groups A and B as comparable as possible by age, gender, and attendance of kindergarten or nursery school. Sampling was opportunistic initially but followed by snowball sampling thereafter. The above-mentioned 22 professional researchers recruited children of both groups A and B, following a common procedure manual based on the above-mentioned criteria. The company instructed researchers on the number (six or seven) of children to be recruited according to their attribution, such as a 4-yr-old boy attending kindergarten, a 5-yr-old girl who does not attend kindergarten or nursery school, a 6-yr-old boy attending nursery school, etc.

According to the international ethical standards (Touitou et al., 2006), each researcher explained the survey details to the caretakers of the children and obtained written informed consent at the time of their visit. At this time, researchers confirmed that the caretakers reported no obvious chronic disorders, including autism, ADHD, or intellectual disability, and no chronic medication use. Because caffeine use is uncommon in Japanese youngsters, we did not inquire about caffeine consumption of the participating children. After obtaining informed consent, the self-completion questionnaires, diary, and Japanese version of the CBCL for 4–18-yr-olds were distributed to the caretakers with instructions to return them by mail. The questionnaires consisted of items that could have an effect on behavior, such as birth weight, family structure, parents' employment status, and type of housing. The diary documenting the children's living habits, including the times when the children went to bed and woke-up for both naps and nocturnal sleep, was recorded daily for two weeks, from June 25 to July 8, 2005. The parents were paid 5,000 yen compensation (~50 U.S. dollars).

## Child Behavior Checklist (CBCL)

The CBCL is made up of questions relating to a total of 113 items categorized into the following eight subscale items: (I) Withdrawn; (II) Somatic complaints; (III) Anxious/depressed; (IV) Social problems; (V) Thought problems; (VI) Attention problems; (VII) Delinquent behavior; and (VIII) Aggressive behavior. Internalizing (I + II + III), externalizing (VII + VIII), and total scales were also derived. Caretakers answered each question by selecting one of three choices of answers (i.e., 0 = not true, 1 = somewhat or sometimes true, and 2 = very true or often true). The eight subscale items and raw scores for the internalizing, externalizing, and total scales were then calculated from these scores of the answers. The raw scores were then converted into T-scores according to the profile sheet (Achenbach, 1991; Itani et al., 2001). It has been previously found that the higher the score, the greater the likelihood of problematic behavior in that scale (Achenbach 1991). According to the T-score, each item and the scales were classified into three clinical categories of behavior (i.e., normal, borderline, and abnormal; Achenbach, 1991).

### Data Analysis

The times recorded in the diaries were used to determine the bed and wake-up times, from which the nocturnal sleep duration was calculated. Nap duration was also determined from the times recorded in the diaries, and the total sleep duration was calculated by adding the nap and nocturnal sleep duration together. The averaged data for wake-up times, bed times, nocturnal sleep duration, nap duration, and total sleep duration for the two weeks were used for analysis. The range of variation in the bedtime at night was calculated using the difference between the earliest and latest bedtimes during the two-week study period, and the range of variation in the wake-up time in the morning was calculated in the same way using the wake-up times.

We compared the T-scores and the distribution of the three clinical classifications between the children of groups A and B on each of the eleven scales examined (the eight items and three scales). Two questions in the CBCL asked about sleep; #92 (talks or walks in sleep) and #100 (trouble sleeping). These questions also asked caretakers to describe the behavior concretely and freely. We assessed the distribution of answers (0 = not true, 1 = somewhat or sometimes true, and 2 = very true or often true) to these two questions between the children of groups A and B, and we categorized the free descriptions of these questions. For each of the total of eleven scales, correlation coefficients between T-scores and each of the seven sleep habits (wake-up times, bedtimes, nocturnal sleep duration, nap duration, total sleep duration, and range of variation in both the wake-up time and bedtime) were assessed. In addition, the distribution of the three clinical classifications for each of the eleven scales was examined between exceptional children who scored in the $\leq 25$ percentile for each of the seven sleeping habits among all children studied, and those who scored in the ≥75 percentile. Consequently, we defined the following exceptional groups of children: early and late risers, early and late sleepers, long and short nocturnal sleepers, long and short nap sleepers, long and short total sleepers, irregular and regular risers, and irregular and regular sleepers. For example, long total sleepers were children whose total sleep duration (nocturnal sleep duration + nap duration) was in the 75 percentile or longer category, while short total sleepers were the children whose total sleep duration was in the 25 percentile or shorter category. Similarly, irregular risers were the children whose range of variation in the wake-up time was in the 75 percentile or larger category, while regular risers were the children whose range of variation in the wake-up time was in the 25 percentile or smaller category.

T-scores were compared by means of t-test, as was the significance of correlation coefficients. The distributions of the clinical classifications and the answers to questions #92 and #100 were assessed using the chi-square test for independence. JMP Statistical Discovery Software version 5 (SAS Institute Japan Ltd.) was used for all analyses; $p < 0.05$ was considered statistically significant.

## RESULTS

### Subjects

Of the 70 children recruited into groups A and B, three withdrew and two failed to complete the CBCL, leaving 68 children in group A and 67 in group B. Children who attended neither kindergarten nor nursery school were not recruited.

### Background Factors

We compared groups A and B by age, gender, number of children attending kindergarten or nursery school, number of siblings, ratio of older brothers or sisters, mothers' age and employment status, and type of housing (see Table 1). There was no significant difference in any of the factors between groups.

### Comparison between Groups A and B

No apparent abnormal data were found among CBCL scores and diary data. Children in group A showed a significantly shorter average duration of nocturnal sleep and total sleep, significantly longer average nap duration, significantly later average bedtimes and wake-up times, and a significantly wider average range of variation in bedtimes and wake-up times than children in group B (see Table 2).

**TABLE 1** Comparison of Demographic and Background Factors between Groups A and B

| Variable | Group A (n = 68) | Group B (n = 67) | Significance |
|---|---|---|---|
| Age: 4/5/6 yrs, mean ± SD | 29/34/5, 4.7 ± 0.6 | 30/31/6, 4.6 ± 0.6 | NS |
| Male/female | 34/34 | 34/33 | NS |
| Attending kindergarten/nursery school | 53/15 | 52/15 | NS |
| Existence of siblings, yes/no | 53/15 | 60/7 | NS |
| Ratio of older brothers or sisters | 68% | 75% | NS |
| Mothers' age: 20s/30s/40s | 15/46/7 | 10/49/8 | NS |
| Mothers' employment status and type of housing: full-time/part-time/business at home/housekeeping | 9/20/4/35 | 4/17/4/42 | NS |

SD = standard deviation.

A significant difference in the T scores of the CBCL between groups A and B was detected in the three subscale (withdrawn, anxious/depressed, and aggressive behavior) items, and in the internalizing, externalizing, and total scales (see Table 3). However, the distribution of children classified into normal, borderline, and abnormal categories between groups A and B showed no significant differences in all eleven scales examined.

The distribution of answers (0 = not true, 1 = somewhat or sometimes true, and 2 = very true or often true) to question #92 showed no significant difference between groups A and B, whereas there was a significant difference ($p < 0.001$) for question #100. The numbers of answers to #100 were 50, 7, and 11 for the answers of 0, 1, and 2 in group A and 63, 4, and 0 in group B, respectively. Thus, a total of 22 answers did not mark 0 for question #100, and 19 out of these 22 answers had free descriptions. Fifteen out of these 19 descriptions listed complaints of late bedtimes, and long nap duration, short sleep duration, abundant body movement, and use of a pacifier were the other descriptions. No other description was found for question #100. For question #92, a total of 22

**TABLE 2** Difference in Sleep Habits between Groups A and B[a]

| Variable | Group A | Group B | Significance |
|---|---|---|---|
| Wake-up time | 7:51 h ± 40 min | 7:08 h ± 24 min | $p < 0.01$ |
| Bedtime | 22:51 h ± 39 min | 20:46 h ± 28 min | $p < 0.01$ |
| Nocturnal sleep duration | 9:02 h ± 44 min | 10:22 h ± 32 min | $p < 0.01$ |
| Nap duration | 45 ± 39 min | 21 ± 27 min | $p < 0.01$ |
| Total sleep duration | 9:46 h ± 46 min | 10:43 h ± 35 min | $p < 0.01$ |
| Range of wake-up time | 1:58 h ± 53 min | 1:19 h ± 39 min | $p < 0.01$ |
| Range of bedtime | 2:40 h ± 77 min | 1:31 h ± 61 min | $p < 0.01$ |

[a]Mean ± SD.