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、カウンセリング等）に加え、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。

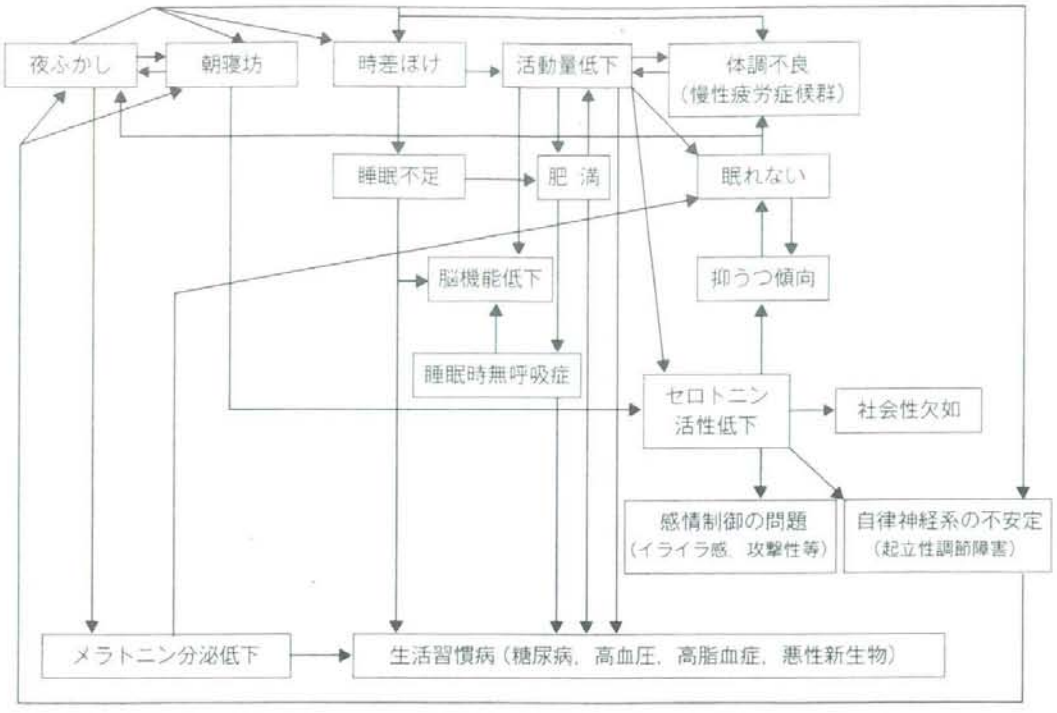

図1　夜ふかし朝寝坊がもたらす心身の諸問題

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□■□

1）全国養護教員会：平成18年度児童・生徒の生活と睡眠に関する調査，2007. 2) Kaneita Y, et al : Sleep 29 : 1543, 2006. 3) American Academy of Sleep Medicine : The International Classification of Sleep Disorder 2nd ed, Westchester, 2005. 4）神山　潤：睡眠の生理と臨床（第2版），診断と治療社，東京，2008. 5) Uchiyama M, et al : Sleep 23 : 553, 2000. 6) Scheer FA, et al : Principles and Practice of Sleep Medicine, 4th ed, Elsevier Saunders, Philadelphia 2005, p395. 7）大川匡子：精神医学 42 : 1317, 2000. 8) Mindell JA, et al : Pediatrics 117 : e1223, 2006. 9）土井由利子：治療 89 : 6, 2007. 10) Guilleminault C, et al : Sleep 31 : 953, 2008. 11) Pressman MR : Sleep 30 : 1039, 2007. 12）神山　潤：脳と発達 40 : 277, 2008. 13) Giannotti F, et al : J Sleep Res 11 : 191, 2002. 14) Wolfson AR, et al : Sleep Med Rev 7 : 491, 2003. 15）原田哲夫：小児保健 63 : 202, 2004. 16) Gau SS, et al : Sleep 27 : 512, 2004. 17) Caci H, et al : Psychiatry Res 134 : 259, 2005. 18) Gau SS, et al : J Biol Rhythms 22 : 268, 2007. 19) Susman EJ, et al : Dev Psychol 43 : 811, 2007. 20) Yokomaku A, et al : Chronobiol Int 25 : 549, 2008. 21) Sasaki M, et al : Aviat Space Environ Med 57 : B29, 1986. 22) Minors DS, et al : Neurosci Lett 133 : 36, 1991. 23) Terman M, et al : Principles and Practice of Sleep Medicine, 4th ed, Elsevier Saunders, Philadelphia, 2005, p1424. 24) Mallis MM, et al : Aviat Space Environ Med 76 (6 Suppl) : B94, 2005. 25) Arendt J, et al : Principles and Practice of Sleep Medicine, 4th ed, Elsevier Saunders, Philadelphia,2005, p659. 26) Cagampang FR, et al : Neuroreport 5 : 49, 1993. 27) Raleigh MJ, et al : Brain Res 559 : 181, 1991. 28) Linnoila VM, et al : J Clin Psychiatry 53 : 46, 1992. 29) Jacobs BL, et al : Trends Neurosci 16 : 346, 1993. 30) Lewy AJ, et al : Sience 210 (4475) : 1267, 1980. 31) Ohta H, et al : Nat Neurosci 8 : 267, 2005. 32) Ukai H, et al : Nat Cell Biol 9 : 1327, 2007. 33) Kohyama J : Brain Dev, in press.

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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.

TABLE 3 Comparison between Groups A and B

Variable	Group A (n = 68)			Group B (n = 67)			*p* value for score	*p* value for the clinical distribution
	Mean	SD	N, B, Ab	Mean	SD	N, B, Ab		
I. Withdrawn	55.3	6.6	66, 1, 1	53.0	4.9	66, 0, 1	<0.05	NS
II. Somatic complaints	51.9	4.1	67, 0, 1	51.1	3.3	66, 1, 0	NS	NS
III. Anxious/ depressed	54.6	6.6	65, 1, 2	52.6	4.1	66, 0, 1	<0.05	NS
IV. Social problems	54.4	5.8	65, 1, 2	52.9	4.1	66, 1, 0	NS	NS
V. Thought problems	51.8	5.8	64, 1, 3	50.5	3.3	66, 0, 1	NS	NS
VI. Attention problems	53.9	5.8	66, 2, 0	52.8	4.1	67, 0, 0	NS	NS
VII. Delinquent behavior	55.9	6.6	62, 4, 2	54.5	4.9	65, 2, 0	NS	NS
VIII. Aggressive behavior	56.4	7.4	63, 2, 3	53.9	4.9	66, 1, 0	<0.05	NS
Internalizing	52.7	8.2	58, 3, 7	49.6	6.5	64, 0, 3	<0.05	NS
Externalizing	54.9	9.1	54, 4, 10	51.7	7.4	58, 2, 7	<0.05	NS
Total	54.0	9.1	54, 4, 10	49.8	8.2	62, 2, 3	<0.01	NS

Abbreviations: N = normal; B = borderline; Ab = abnormal; NS = not significant.

answers did not mark 0, and 21 of these 22 answers had free descriptions. Twelve listed complaints of "talking in their sleep," and the other 9 complained of "walking in their sleep."

Correlation between Sleeping Habits and T-Scores

High and statistically significant positive correlation coefficient values (>0.22) were obtained between the following:

- wake-up times and "withdrawn," "social problems," "attention problems," "aggressive behavior," internalizing, externalizing, and total scales;
- bedtimes and "withdrawn," "anxious/depressed," "social problems," "aggressive behavior," internalizing, and total scales;
- wake-up time range of variation and "social problems," "attention problems," "aggressive behavior," and total scales; and
- bedtime range of variation and total scales (see Table 4).

Although sleep duration did not exhibit a significant correlation with the total scale, the total scale showed highly positive significant correlations with wake-up times, bedtimes, and both wake-up time and bedtime range of variation. The total scale did not differ in a statistically significant manner between kindergarten and nursery school children.

TABLE 4 Correlation Coefficients between Sleep Habits and T-scores on Each Scale

Variable	Wake-up times	Bedtimes	Nocturnal sleep duration	Nap duration	Total sleep duration	Wake-up time range	Bedtime range
I. Withdrawn	0.24†	0.25†	−0.16	0.18*	−0.08	0.22*	0.15
II. Somatic complaints	0.09	0.11	−0.08	0.02	−0.08	0.09	0.13
III. Anxious/ depressed	0.19*	0.26†	−0.20*	0.21*	−0.10	0.16	0.17*
IV. Social problems	0.30†	0.23†	−0.09	0.01	−0.09	0.27†	0.14
V. Thought problems	0.17*	0.21	−0.16	0.19*	−0.08	0.19*	0.12
VI. Attention problems	0.31†	0.16	0.02	0.09	0.07	0.32†	0.14
VII. Delinquent behavior	0.20*	0.16	−0.07	0.00	−0.10	0.15	0.20*
VIII. Aggressive behavior	0.32†	0.23†	−0.06	0.08	−0.03	0.26†	0.22*
Internalizing	0.23†	0.26†	−0.18*	0.15	−0.12	0.19*	0.20*
Externalizing	0.27†	0.21*	−0.07	0.04	−0.07	0.20*	0.21*
Total	0.33†	0.26†	−0.10	0.09	−0.06	0.27†	0.24†

Statistical significance: *$p < 0.05$; †$p < 0.01$.

Comparison of Clinical Classification and Exceptional Sleeping Habits

The distribution of clinical classification and total scale score showed significant differences between early and late risers (Normal/Borderline/Abnormal = 29/0/2; early risers, 20/2/7; late risers, $p < 0.05$), and also between regular and irregular sleepers (37/1/1; regular sleepers, 22/0/9; irregular sleepers, $p < 0.01$). The number of children classified as normal, with reference to the total scale, was higher in early risers and regular sleepers than in late risers and irregular sleepers. Correspondingly, the number of children classified as abnormal, with reference to the total scale, was higher in late risers and irregular sleepers than in early risers and regular sleepers. In addition, the distribution of clinical classifications of regular sleepers also showed significant differences for delinquent behavior (39/0/0; regular sleeper, 25/6/0; irregular sleeper, $p < 0.01$), as well as for the internalizing scale (38/0/1; regular sleeper, 23/1/7; irregular sleeper, $p < 0.05$). No other significance differences for the clinical classifications between children exhibiting exceptional sleeping habits were obtained.

The distribution of the clinical classification in terms of the total scale showed no significant difference between kindergarten and nursery school children.

DISCUSSION

We examined the association between sleep habits and behaviors of healthy preschool children. We believe that problematic behaviors are associated with late and irregular wake-up times and bedtimes, but not with sleep duration. However, before discussing this issue, several other issues remain to be discussed.

Based on our common sense, for children aged 4–6 yrs, it might be hard to understand how and why the caretakers of children of group A allowed a bedtime after 23:00 h, to return home with their children after 21:00 h, and to leave home with their children after 21:00 h. In Japan, these conditions are not uncommon, not only in the urban areas but also in the rural areas, partly because many shopping centers are open 24 h and there is unrestricted access to media around the clock. Unfortunately, we were confident the three criteria we determined were not peculiar for most people in Japan, 2005. Nonetheless, this was not the case for those children of group B. It is of interest that no other differences were found between groups A and B (see Table 1).

CBCL, which has been translated into 58 languages, is currently the standard method used for evaluating behavioral problems in children. Its scaling system is widely accepted as being consistent, and it bypasses national and cultural differences. It was previously found that the higher the score, the greater the possibility of problematic behaviors in that scale (Achenbach, 1991); however, high CBCL scores do not mean "undesirable behaviors."

This preliminary study has several limitations. For example, no objective measures were applied to the data on sleep habits. Acebo et al. (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. The present study neglected nocturnal waking because of a lack of measuring tools. Further investigations combined with objective measures are therefore warranted in the future. Another limitation of this study was the partial inability to control for the economic background among the caretakers of our young subjects. Socioeconomic (Clarisse et al., 2004), ethnic, and sociocultural environments (Giannotti et al., 2005) of the family are known to affect sleep habits of children. Although our subjects were all Japanese, data on the income of each family were not obtained. However, mother's employment status, which partially reflects socioeconomic status (Anderson et al., 2003), did not differ between groups A and B. In future studies, various other factors, including educational background and the income of each caretaker, should be taken into consideration. Question #92 of the CBCL asked about "talks or walks in sleep." There were no significant differences among the answer categories (not true,

somewhat or sometimes true, and very true or often true) for this question between groups A and B. Although no direct questions were asked about sleep-related respiratory disturbances, no descriptions, such as snoring or sleep apnea, were found for question #100 of the CBCL that specifically addressed "trouble sleeping." According to these results, we concluded that no obvious sleep disturbances were likely to have affected the current results. Finally, we did not ask about media exposure, although the association between the duration of television viewing and the irregularity of sleep habits in young children has been described (Thompson & Christakis, 2005). This issue should be taken into consideration in future studies.

The current preliminary study demonstrated three issues. First, sleep duration did not affect either total T-scores or the distribution of clinical classification. Second, children in group A showed significantly higher T-scores for some of the eleven scales (including the total scale) than those in group B. The later the wake-up time and bedtime, the higher the total CBCL scale and the greater the range of variation in the wake-up and bedtimes. Third, the distribution of the clinical classifications by the total scale showed significant differences between early and late risers, and also between regular and irregular sleepers. The number of children classified into normal by the total scale was higher in early risers and regular sleepers than in late risers and irregular sleepers. The first issue indicated little association between problematic behaviors and sleep duration. Both of the other two issues showed an association between problematic behaviors and group A, late risers, late sleepers, irregular risers, and irregular sleepers.

With regard to the first issue, we need to consider that in adults there are both long and short sleepers. Such habits are considered to develop at a young age (American Academy of Sleep Medicine, 2005). The required sleep duration of an individual person is very difficult to determine, because the need for sleep is variable and can depend on several factors (Carskadon & Dement, 2005). Such interindividual variability might, therefore, have produced the present results that sleep duration showed little association with CBCL T-scores as well as the distribution of clinical classification.

Two possibilities were raised from the obtained association between problematic behaviors and group A, late risers, late sleepers, irregular risers, and irregular sleepers. Children who had higher CBCL scores were likely to show similar sleeping habits to group A, and children who exhibited similar sleeping habits to Group A had a greater possibility of exhibiting problematic behaviors. With regard to the former possibility, children with autism, ADHD, or intellectual disability are known to have sleep problems (O'Brien et al., 2003; Richdale, 2001; Robinson & Richdale, 2004). In addition, CBCL is reported to be a useful instrument

to identify autistic and ADHD children (Chen et al., 1994; Duarte et al., 2003). However, according to the current CBCL as well as the caretakers' self report, no participating children in our study were considered to be suffering from chronic disorders, such as autism, ADHD, or intellectual disability. Thus, it is unlikely that the present results were affected by such disordered children. Moreover, it could be assumed that behavioral problems that appeared around sleep-onset time resulted in difficulty in falling asleep. Although the distribution of answers to question #100 that addressed trouble sleeping showed a significant difference between the children of group A versus group B, no concrete child behavior that prevented them from falling asleep was described in the free description column. Further studies are needed to confirm the possibility that children who have higher CBCL scores are likely to show similar sleeping habits as children of group A.

Many reports have described that the evening type, which is often accompanied by delayed wake-up times, delayed bedtimes, and an irregular lifestyle, is associated with problematic behaviors (Caci et al., 2005; Carney et al., 2006; Gau et al., 2004, 2007; Gaina et al., 2006; Monk et al., 2004; Soehner et al., 2007; Susman et al., 2007). These reports are consistent with the current results that preschool children who showed similar sleep habits as group A showed a greater risk of showing problematic behaviors. Kerkhof and Van Dongen (1996) mentioned that the endogenous phasing of their circadian biological clock of individuals with morning types differs from that of evening types. According to Bailey and Heitkemper (2003), evening types have a later morning temperature rise and later wake-up time than do morning types. Moreover, individuals who are maximally alert in the morning have an earlier peak in their temperature circadian rhythm than individuals who are most alert in the evening (Duffy et al., 2001). These reports suggested that evening types suffer from circadian desynchronization (Katz et al., 2001; Rivkees, 2001). Taking these reports into consideration, we hypothesize that children with an evening preference (preschool children who belonged to group A as well as late risers, late sleepers, irregular risers, and irregular sleepers in the current study) suffer from circadian desynchronization.

Exposure to morning light and avoidance of nocturnal light are essentially important for human beings to synchronize their biological clock to the Earth's 24 h cycle (Minors et al., 1991). Without this synchronization, one could be suffering from circadian desynchronization, resulting in various physical and mental disturbances (Arendt et al., 2005). In addition, exposure to sunlight in the morning is known to activate the serotonergic system (Cagampang et al., 1993). The concept of low serotonin syndrome—as characterized by aggressiveness, impulsiveness, and suicidal attempts—has been previously proposed (Linnoila et al., 1992). Reduced

serotonergic activity was reported to be a disadvantage and enhanced activity an advantage to adult male vervet monkeys in attaining high social dominance status (Raleigh et al., 1991). For adolescents, Gaina et al. (2006) and Gau et al. (2007) recommended a morning preference to reduce behavioral/emotional problems. The current, preliminary study suggests that this recommendation should extend to preschoolers.

REFERENCES

Acebo C, Sadeh A, Seifer R, Tzischinsky O, Hafer A, Carskadon MA. (2005). Sleep/wake patterns derived from activity monitoring and maternal report for healthy 1- to 5-year-old children. *Sleep* 28:1568–1577.

Achenbach TM. (1991). *Manual for the Child Behavior Checklist/4–18 and 1991 Profile*. Burlington, Vt.: University of Vermont Department of Psychiatry.

American Academy of Sleep Medicine. (2005). *The International Classification of Sleep Disorder*, 2nd edn. Westchester, III.

Anderson PM, Butcher KF, Levine PB. (2003). Maternal employment and overweight children. *J. Health Econ.* 22:477–504.

Arendt J, Stone B, Skene DJ. (2005). Sleep disruption in jet lag and other circadian rhythm-related disorders. In Kryger MH, Roth T, Dement WC (eds.) *Principles and Practice of Sleep Medicine*, 4th edn. Elsevier Saunders, pp. 659–672.

Bailey SL, Heitkemper MM. (2003). Circadian rhythmicity of cortisol and body temperature: Morningness-eveningness effects. *Chronobiol. Int.* 18:249–261.

Benesse Corporation. (2005). *The Third Infant's Life Questionnaire Report, 2005*. Tokyo: Benesse [in Japanese].

Caci H, Mattei V, Bayle FJ, Nadalet L, Dossios C, Robert P, Boyer P. (2005). Impulsivity but not venturesomeness is related to morningness. *Psychiatry Res.* 134:259–265.

Cagampang FR, Yamazaki S, Otori Y, Inouye SI. (1993). Serotonin in the raphe nuclei: Regulation by light and an endogenous pacemaker. *Neuroreport* 5:49–52.

Carney CE, Edinger JD, Meyer B, Lindman L, Istre T. (2006). Daily activities and sleep quality in college students. *Chronobiol. Int.* 23:623–637.

Carskadon MA, Dement WC. (2005). Normal human sleep: an overview. In Kryger MH, Roth T, Dement WC (eds.) *Principles and Practice of Sleep Medicine*, 4th edn. Elsevier Saunders, pp. 13–23.

Chen WJ, Faraone SV, Biederman J, Tsuang MT. (1994). Diagnostic accuracy of the Child Behavior Checklist scales for attention-deficit hyperactivity disorder: A receiver-operating characteristic analysis. *J. Consult. Clin. Psychol.* 62:1017–1025.

Clarisse R, Testu F, Maintier C, Alaphilippe D, Le Floc'h N, Janvier B. (2004). A comparative study of nocturnal sleep duration and timetable of children between five- and ten-years-old according to their age and socio-economic environment (in French). *Arch. Pediatr.* 11:85–92.

Cornwell AC, Feigenbaum P. (2006). Sleep biological rhythms in normal infants and those at high risk for SIDS. *Chronobiol. Int.* 23:935–961.

Duarte CS, Bordin IA, de Oliveira A, Bird H. (2003). The CBCL and the identification of children with autism and related conditions in Brazil: Pilot findings. *J. Autism Develop. Dis.* 33:703–707.

Duffy JF, Rimmer DW, Czeisler CA. (2001). Association of intrinsic circadian period with morningness-eveningness, usual wake time, and circadian phase. *Behav. Neurosci.* 115:895–899.

Gaina A, Sekine M, Kanayama H, Takashi Y, Hu L, Sengoku K, Kagamimori S. (2006). Morning-evening preference: Sleep pattern spectrum and lifestyle habits among Japanese junior high school pupils. *Chronobiol. Int.* 23:607–621.

Gau SS, Soong WT, Merikangas KR. (2004). Correlates of sleep-wake patterns among children and young adolescents in Taiwan. *Sleep* 27:512–519.

Gau SS, Shang CY, Merikangas KR, Chiu YN, Soong WT, Cheng AT. (2007). Association between morningness-eveningness and behavioral/emotional problems among adolescents. *J. Biol. Rhythms.* 22:268–274.

Giannotti F, Cortesi F, Sebastiani T, Vagnoni C. (2005). Sleeping habits in Italian children and adolescents. *Sleep Biol. Rhythms* 3:15–21.

Itani T, Kanbayashi Y, Nakata Y, Kita M, Fujii H, Kuramoto H, Negishi A, Tuduka M, Okada A, Natori H. (2001). Study on validity of the Japanese version of CBCL/4–18. *Shyoni No Seishin To Shinkei* 4:243–252 [in Japanese].

Janvier B, Testu F. (2007). Age-related differences in daily attention patterns in preschool, kindergarten, first-grade, and fifth-grade pupils. *Chronobiol. Int.* 24:327–343.

Katz G, Durst R, Zislin Y, Barel Y, Knobler HY. (2001). Psychiatric aspects of jet lag: Review and hypothesis. *Med. Hypotheses* 56:20–23.

Kerkhof GA, Van Dongen HP. (1996). Morning-type and evening-type individuals differ in the phase position of their endogenous circadian oscillator. *Neurosci. Lett.* 218:153–156.

Kohyama J, Shiiki T, Ohinata-Sugimoto J, Hasegawa T. (2002). Potentially harmful sleep habits of three-year-old children in Japan. *J. Dev. Behav. Pediatri.* 23:67–70.

Kohyama J, Furushima W, Hasegawa T. (2003). Behavioral problems in children evaluated for sleep disordered breathing. *Sleep Hypnosis* 5:89–94.

Lehnkering H, Siegmund R. (2007). Influence of chronotype, season, and sex of subject on sleep behavior of young adults. *Chronobiol. Int.* 24:875–888.

Linnoila VM, Virkkunen M. (1992). Aggression, suicidality, and serotonin. *J. Clin. Psychiatry* 53 (Suppl.):46–51.

Mallis MM, DeRoshia CW. (2005). Circadian rhythms, sleep, and performance in space. *Aviat. Space Environ. Med.* 76(6 Suppl.):B94–B107.

Mieda M, Williams SC, Richardson JA, Tanaka K, Yanagisawa M. (2006). The dorsomedial hypothalamic nucleus as a putative food-entrainable circadian pacemaker. *Proc. Natl. Acad. Sci. USA.* 103: 12150–12155.

Minors DS, Waterhouse JM, Wirz-Justice A. (1991). A human phase-response curve to light. *Neurosci. Lett.* 133:36–40.

Mitchell RB, Kelly J. (2006). Behavior, neurocognition and quality-of-life in children with sleep-disordered breathing. *Int. J. Pediatr. Otorhinolaryngol.* 70:395–406.

Monk TH, Buysse DJ, Potts JM, DeGrazia JM, Kupfer DJ. (2004). Morningness-eveningness and lifestyle regularity. *Chronobiol. Int.* 21:435–443.

O'Brien LM, Ivanenko A, Crabtree VM, Holbrook CR, Bruner JL, Klaus CJ, Gozal D. (2003). Sleep disturbances in children with attention deficit hyperactivity disorder. *Pediatr. Res.* 54:237–243.

Ohayon MM, Vecchierini MF. (2005). Normative sleep data, cognitive function and daily living activities in older adults in the community. *Sleep* 28:981–989.

Raleigh MJ, McGuire MT, Brammer GL, Pollack DB, Yuwiler A. (1991). Serotonergic mechanisms promote dominance acquisition in adult male vervet monkeys. *Brain Res.* 559:181–190.

Randazzo AC, Muehlbach MJ, Schweitzer PK, Walsh JK. (1998). Cognitive function following acute sleep restriction in children ages 10–14. *Sleep* 21:861–868.

Richdale A. (2001). Sleep in children with autism and Asperger's syndrome. In Stores G, Wiggs L (eds.) *Sleep Disturbance in Children and Adolescents with Disorders of Development. Its Significance and Management*. Cambridge: Cambridge University Press, pp. 181–191.

Rivkees SA. (2001). Mechanisms and clinical significance of circadian rhythms in children. *Curr. Opin. Pediatri.* 13:352–357.

Robinson AM, Richdale AL. (2004). Sleep problems in children with an intellectual disability: Parental perceptions of sleep problems, and views of treatment effectiveness. *Child Care Health Dev.* 30: 139–150.

Soehner AM, Kennedy KS, Monk TH. (2007). Personality correlates with sleep-wake variables. *Chronobiol Int.* 24:889–903.

Spiegel K, Leproult R, Van Cauter E. (1999). Impact of sleep debt on metabolic and endocrine function. *Lancet* 354:1435–1439.

Spiegel K, Knutson K, Leproult R, Tasali E, Van Cauter E. (2005). Sleep loss: A novel risk factor for insulin resistance and type 2 diabetes. *J. Appl. Physiol.* 99:2008–2019.

Susman EJ, Dockray S, Schiefelbein VL, Herwehe S, Heaton JA, Dorn LD. (2007). Morningness/eveningness, morning-to-afternoon cortisol ratio, and antisocial behavior problems during puberty. *Dev. Psychol.* 43:811–822.

Suzuki M, Takahashi C, Nomura Y, Segawa M. (2002). What do care workers worry about in relationships between modern young children and their parents? *J. Child Health* 61:593–598 [in Japanese].

Suzuki M, Nomura Y, Segawa M. (2003). Influence of the nursing environment on sleep-wake rhythms. *Jap. J. Clin. Ecol.* 12:122–127 [in Japanese].

Suzuki M, Nakamura T, Kohyama J, Nomura Y, Segawa M. (2005). Children's ability to copy triangular figures is affected by their sleep-wakefulness rhythms. *Sleep Biol. Rhythms* 3:86–91.

Taheri S. (2006). The link between short sleep duration and obesity: We should recommend more sleep to prevent obesity. *Arch. Dis. Child.* 91:881–884.

Teixeira LR, Lowden A, Turte SL, Nagai R, Moreno CR, Latorre MDR, Fischer FM. (2007). Sleep and sleepiness among working and non-working high school evening students. *Chronobiol. Int.* 24: 99–113.

Terman M, Terman JS. (2005). Light therapy. In Kryger MH, Roth T, Dement WC (eds.) *Principles and Practice of Sleep Medicine*, 4th edn. Elsevier Saunders, pp. 1424–1442.

The Japanese Society of Child Health. (2000). Health infant degree investigation report in fiscal year 2000. Available at http://www.aiiku.or.jp/aiiku/jigyo/contents/kanren/kr0108/kr0108.htm [in Japanese]. Accessed October 13, 2006.

Thompson DA, Christakis DA. (2005). The association between television viewing and irregular sleep schedules among children less than three years of age. *Pediatrics* 116:851–856.

Touitou Y, Smolensky MH, Portaluppi F. (2006). Ethics, standards, and procedures of animal and human chronobiology research. *Chronobiol. Int.* 23:1083–1096.

Ukai H, Kobayashi TJ, Nagano M, Masumoto KH, Sujino M, Kondo T, Yagita K, Shigeyoshi Y, Ueda HR. (2007). Melanopsin-dependent photo-perturbation reveals desynchronization underlying the singularity of mammalian circadian clocks. *Nat. Cell Biol.* 9:1327–1334.

Waterhouse J, Reilly T, Atkinson G, Edwards B. (2007). Jet lag: Trends and coping strategies. *Lancet* 368:1117–1129.

Wever RA. (1979). *The Circadian System of Man: Results of Experiments Under Temporal Isolation*. New York: Springer-Verlag.

Wolfson AR, Carskadon MA. (1998). Sleep schedules and daytime functioning in adolescents. *Child Dev.* 69:875–887.

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Review article

A newly proposed disease condition produced by light exposure during night: Asynchronization

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Abstract

The bedtime of preschoolers/pupils/students in Japan has become progressively later with the result sleep duration has become progressively shorter. With these changes, more than half of the preschoolers/pupils/students in Japan recently have complained of daytime sleepiness, while approximately one quarter of junior and senior high school students in Japan reportedly suffer from insomnia. These preschoolers/pupils/students may be suffering from behaviorally induced insufficient sleep syndrome due to inadequate sleep hygiene. If this diagnosis is correct, they should be free from these complaints after obtaining sufficient sleep by avoiding inadequate sleep hygiene. However, such a therapeutic approach often fails. Although social factors are often involved in these sleep disturbances, a novel clinical notion – asynchronization – can further a deeper understanding of the pathophysiology of these disturbances. The essence of asynchronization is a disturbance in various aspects (e.g., cycle, amplitude, phase and interrelationship) of the biological rhythms that normally exhibit circadian oscillation, presumably involving decreased activity of the serotonergic system. The major trigger of asynchronization is hypothesized to be a combination of light exposure during the night and a lack of light exposure in the morning. In addition to basic principles of morning light and an avoidance of nocturnal light exposure, presumable potential therapeutic approaches for asynchronization involve both conventional ones (light therapy, medications (hypnotics, antidepressants, melatonin, vitamin B12), physical activation, chronotherapy) and alternative ones (kampo, pulse therapy, direct contact, control of the autonomic nervous system, respiration (qigong, tanden breathing), chewing, crawling). A morning-type behavioral preference is described in several of the traditional textbooks for good health. The author recommends a morning-type behavioral lifestyle as a way to reduce behavioral/emotional problems, and to lessen the likelihood of falling into asynchronization.

Keywords: Desynchronization; Serotonin; Morningness; Eveningness; Sleep; Circadian rhythm

1. Introduction

The suprachismatic nucleus (SCN) is the site where circadian rhythms are generated. The SCN develops throughout the course of gestation, but is still immature for some time after birth. The SCN is suggested to be vulnerable to maternal influences [1]. Since disturbances of circadian rhythms in the young can impact the function of the SCN in the subsequent lifespan, techniques to deal with them are much needed. However, we have little knowledge about the pathophysiology of the disruption of circadian rhythms in the clinical setting, making it difficult to find an appropriate clinical approach to treating these patients. It is very difficult at present to take adequate measures against circadian disruptions in patients.

This review article introduces the recent phenomenon of a nocturnal lifestyle among preschoolers/pupils/students in Japan, and the association between this nocturnal lifestyle and behavior. Then, the presumed involvement of the biological clock and the serotonergic

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