Influence of social factors on the sleep-wake cycle in children

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ABSTRACT
In children, the sleep-wake cycle (SWC) is influenced by both social and biological factors. Recently, lifestyle changes have introduced a number of social factors that negatively impact sleeping patterns. This review characterizes the sleep-wake cycle and describes how social factors influence this cycle in children. Social factors such as bed-sharing and room-sharing, as well as media use, the family environment, and the school schedule, all impact a child’s routine and affect health and well-being. While a routine can benefit a child’s health, in some situations these factors can delay the beginning of sleep and negatively impact the sleep-wake cycle. When coupled with a school schedule that begins early in the morning, these factors can result in partial sleep deprivation, sleep disturbances, and irregular sleeping and waking times. These sleeping problems can result in low school performance, obesity, attention-deficit/hyperactivity disorder, and to be a predictor of insomnia in adolescents.

Keywords: Sleep-wake transition disorders; Socioeconomic factors; Child; Sleep deprivation; Sleep disorders

RESUMO
O ciclo sono e vigília (CSV) de crianças é influenciado por fatores biológicos e sociais. Entretanto, devido ao estilo de vida atual, as mudanças sociais aumentam e apresentam um impacto negativo no padrão de sono. Essa revisão tem como objetivo caracterizar o ciclo sono e vigília e a influência de fatores sociais sobre esse ciclo em crianças. O co-leito, quarto compartilhado, uso da mídia, ambiente familiar e horário escolar são alguns dos fatores sociais que fazem parte da rotina da criança e trazem benefícios para a saúde e o bem-estar. Entretanto, em algumas situações podem retardar o início do sono interferindo de forma negativa no ciclo sono e vigília de crianças, na medida em que associados ao horário escolar matutino, provocam irregularidade nos horários de dormir e acordar, privação parcial de sono e distúrbios de sono. Essas alterações podem ter como consequências um baixo desempenho escolar, obesidade, transtorno de déficit de atenção e hiperatividade e o aparecimento da insônia na adolescência.

Descritores: Distúrbios da transição sono-vigília; Fatores socioeconômicos; Criança; Privação do sono; Distúrbios de sono

INTRODUCTION
The sleep-wake cycle (SWC) is one of the most extensively studied biological rhythms in humans. Previous research has shown that sleep plays an important role in restoring physiological and biochemical processes, consolidating memory, and maintaining energetic balance.

The SWC is regulated throughout the day via two processes: the circadian and the homeostatic process. The circadian process regulates the alternation between sleeping and waking states by initiating or preventing sleep at specific times throughout the day. While this process regulates sleep based on time, the homeostatic process controls sleeping patterns based on the duration of previous waking and sleeping states. Upon waking, there is little desire to sleep, but it increases as the waking state progresses—ultimately resulting in sleep. During sleeping states, the homeostatic process gradually decreases the desire to sleep until waking is initiated.

Thus, the interaction between the homeostatic and the circadian processes regulates the initiation and the cessation of sleep, and the maintenance of the states of sleep and wake.

The SWC is also influenced by cultural factors and lifestyle habits that can deprive people of sleep benefits. Because we are now a “twenty-hour society”, nighttime activity has been dramatically increased, impacting the SWC of both adults and children.

Children need an adequate night of sleep to maintain alertness and responsiveness in social interactions. While recent lifestyle changes have caused children to go to bed later during weekdays (because of distractions such as television, the internet, and video games), children must still wake up early for school, resulting in partial sleep deprivation and an irregular sleep schedule. Several studies have associated partial sleep deprivation and health impairments with obesity, reduced cognitive performance, and attention-deficit/hyperactivity disorder. Moreover, these alterations in the SWC can influence a child’s physiological, psychological, emotional, behavioral, and cognitive development. Therefore, this review aimed to characterize the SWC and describe how social factors influence this cycle in children between one month and ten years of age.
SLEEP-WAKE CYCLE

During infancy, newborn children display a polyphasic sleep pattern that is characterized by several episodes of sleep throughout the day\(^{16-18}\). Throughout the first year of life, the SWC begins to synchronize with the environmental light-dark cycle as the neural pathways responsible for synchronizing biological and environmental factors mature\(^{16,17,19}\). As they grow older, children go to bed and wake up earlier, increasing their nighttime sleep while the number of daytime sleep episodes (naps) decreases\(^{16,20}\). This reduction in daytime sleep results in an overall sleep reduction; the average daily duration of sleep decreases from 14 hours, in the first year of life, to 10 hours after 7 years of age (Table 1)\(^{16,19,21-23}\). However, the daily duration of sleep varies between weekdays and weekends\(^{22}\).

However, in view of biological variations in preference with regard to the times of sleeping and waking (diurnal preference) and cultural aspects, there is not a specific age at which a child stops napping\(^{24}\) or a specific pattern of sleep initiation, cessation, or duration at each age\(^{25-28}\). Even children of the same age display different sleep times\(^{18}\). Thus, the daily duration of sleep at each age is only a parameter because each individual's need for sleep varies (Table 1).

In addition to developmental, individual, and cultural changes that affect the SWC, infancy is marked by changes in the social environment, such as beginning school and sleeping alone. Habitual bedtime behaviors (bedtime rituals) and sleep location (bed-sharing or room-sharing with parents) can compensate for these changes by calming the child during the transition between waking and sleeping states.

BED- AND ROOM-SHARING

Some infants share a bed (bed-sharing) or a bedroom (room-sharing) with their parents. These behaviors are a function of culture\(^{29,30}\) and the socio-economic level of the family\(^{31}\).

Several studies have observed that children who share a bed or a bedroom with their parents have higher self-esteem, less anxiety\(^{32}\), greater comfort when feeding\(^{33}\), and more maternal interaction\(^{34}\). However, there is also evidence that these behaviors can have negative effects, such as resistance at bedtime, which delays both sleep and waking and reduces nighttime sleep duration\(^{31}\). In addition, these behaviors are associated with the frequency of nighttime waking and sudden infant death syndrome\(^{35-37}\).

Bed-sharing is common during the first years of life, reaching its maximum occurrence between three and five years of age and then decreasing as the child begins to sleep in its own room\(^{31,38}\). The increased incidence of co-sleeping between three and five years of age is probably caused by increasing locomotor independence\(^{30}\) and the beginning of school, both of which have a strong impact on the SWC of children. A study by Silva et al.\(^{30}\) found that only 7% of school children between seven and ten years of age sleep by themselves.

BEDTIME RITUALS

The most common bedtime rituals are sleeping with a favorite object (transitional object), sleeping with the lights on, drinking milk\(^{10,38}\), calling for a parent at night, and requiring the mother’s presence in the bedroom\(^{10}\).

Children use transitional objects such as blankets, body parts (thumb sucking), toys, or other objects (a pillow, a pacifier, a parent’s clothing, or a stuffed animal) to provide security in the mother's absence and facilitate the transition between waking and sleeping states\(^{18,39-40}\). When the transitional object is part of the bedtime routine, blankets, toys, and pacifiers are used most often. Girls and younger children prefer to sleep with a blanket or toy, but this behavior decreases at approximately five years of age\(^{10,38}\).

No study has yet evaluated the influence of transitional objects on the SWC because previous studies have largely investigated the soothing effects of transitional objects\(^{10,38-41}\).

In addition to transitional objects, other behaviors, such as sleeping with the lights on\(^{10,38}\), drinking milk or other beverages before bedtime\(^{38}\), or calling for a parent at night\(^{10}\), can minimize sleep-related fear and anxiety in children in the first ten years of life.

However, Beltramini and Hertzig\(^{10}\) argue that the bedtime ritual involves several distinct behaviors: 1) putting on pajamas or changing a diaper, 2) drinking a beverage such as milk, 3) listening to a story or song, and 4) a kiss good night. More than 30 minutes a day are necessary to execute this routine, and longer times are required for the execution of these rituals as the child grows older\(^{10}\).

The influence of these additional rituals (sleeping with the lights on, drinking milk and calling for a parent at night) on the SWC is unknown. It should be noted, however, that sleeping with the lights on can suppress the release of melatonin, which is secreted by the pineal gland when there is no light on the retina. Light thus inhibits the release of melatonin, favoring the waking state, whereas the absence of light induces melatonin release and induces the sleep state\(^{42}\). The cyclic variation of

**Table 1: Average and standard deviation of total sleep duration from different questionnaire-based studies**

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Switzerland – Iglowstein et al.(^{29})</th>
<th>Switzerland – Jenni et al.(^{31})</th>
<th>Saudi Arabia – BaHamman et al.(^{32})</th>
<th>Egypt – Abou-Khadera(^{33})</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>13.9±1.2</td>
<td>14.6±1.4</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>11.8±1.0</td>
<td>12.1±1.2</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>7</td>
<td>10.6±0.7</td>
<td>11.1±0.7</td>
<td>9.4±1.3</td>
<td>9.06±1.29</td>
</tr>
<tr>
<td>10</td>
<td>9.9±0.6</td>
<td>10.1±0.6</td>
<td>9.2±1.3</td>
<td>9.06±1.07</td>
</tr>
</tbody>
</table>
light and dark of environment is the main synchronizer of the SWC; therefore, light can both stimulate the release of melatonin and delay the beginning of sleep depending on when the individual is exposed to the stimulus. According to Khalsa et al.\(^{(43)}\), a light pulse between the end of the waking state and the beginning of the sleeping state delays sleeping and waking times, whereas a pulse between the end of the sleeping state and the beginning of the waking state advances these times.

Several studies have shown that adolescents who live in urban areas, which are exposed to artificial light at night, display later sleep times relative to students in rural areas. This difference is caused by artificial light, which delays melatonin release and, consequently, sleep time\(^{(44,45)}\). Nevertheless, further studies are necessary to determine whether sleeping with the lights on affects the SWC of children, and whether this stimulus can delay sleep times in the same way that it affects adolescents in urban areas.

**MEDIA USE**

Some parents incorporate television into their child’s bedtime routine or associate television with their child falling asleep\(^{(46,47)}\). Watching television before bedtime or having a television in the bedroom apparently minimizes difficulties at bedtime. Nevertheless, television can delay the beginning of sleep\(^{(46)}\) and, in the long term, may result in the child requiring television to fall asleep. This dependency results in a vicious cycle in which the television becomes a transitional object.

Using the television as a transitional object not only delays the beginning of sleep, but also leads to irregular sleep times, shorter sleep duration, bedtime resistance, sleep disturbances, and daytime sleepiness\(^{(46-49)}\).

When compared with the television, the computer can have a similar – or even a stronger influence – on the SWC. However, the effects of computers on children’s sleep have only been observed in one Chinese study by Li et al.\(^{(13)}\), who demonstrated that children with computers in their bedrooms not only fall asleep and wake up at later times during weekdays and weekends, but also have shorter sleep durations during weekdays. This study provides evidence that computers have a negative impact on sleep that is similar to the effects of television. However, further studies are required to confirm this effect in children.

Therefore, parents should limit the use of media – particularly in the bedroom – to promote good sleep habits and improve the quantity and quality of the child’s sleep\(^{(15,49)}\).

**FAMILY ENVIRONMENT**

Although parents try to minimize social changes by manipulating bedtime behaviors, there are other factors that can affect sleep quality and a child’s well-being. These factors include family conflicts, marital status, education level, and socioeconomic level\(^{(22,31,48-53)}\).

Nevertheless, parents often fail to recognize that both a child’s well-being and sleeping habits can be negatively affected by a family environment that is not conducive to good sleep habits\(^{(22)}\).

A high level of conflict between parents or other family members can reduce sleep quality in children. Family conflicts reduce the quantity of sleep and increase nighttime sleep fragmentation, both of which result in daytime sleepiness\(^{(50,51)}\). In addition, children in chaotic family environments can develop adolescent insomnia because a family with frequent conflicts often has poor sleep habits. These environments are noisy and lack a routine that supports good quality sleep\(^{(52)}\).

In addition to family conflicts, Phillips\(^{(53)}\) observed that the marital state of parents influences the well-being of children. Children of married parents have higher well-being because they tend to go for walks and are told stories more often than children of single parents. These behaviors may result from the mother or father’s attempt to compensate for the other parent’s absence, according to their work schedule. However, this study did not investigate the relationship between marital status and a child’s sleep patterns.

Parental education level is also related to a child’s sleep. A higher educational level may be associated with a higher quality of sleep because children of illiterate or minimally educated mothers sleep later and display a reduction in total sleep duration (daytime and nighttime sleep)\(^{(22,51)}\).

In addition, children from low socio-economic levels often have more sleep problems because they wake up late, stay in bed for longer periods, and have an increased frequency of nighttime waking. These children may also sleep less efficiently because they have to share their bedroom and the house with more people. These factors, in addition to the low educational level of the parents, often prevent an adequate bedtime routine from being instituted\(^{(15,49,53)}\).

An adequate family environment is thus critical in maintaining regular sleep schedules, providing better sleep quality\(^{(19)}\) and instilling good sleep habits, behaviors that, over time, can have a positive effect on a child’s well-being. Recently, children have been going to bed increasingly late and spending less time sleeping, a trend likely caused by social pressures and the relaxation of parental restrictions\(^{(9,19,56)}\).

**SCHOOL SCHEDULE**

School is one of the most important components of a child’s psychosocial environment, and have a direct impact on sleep schedules. Because of the school start times, children wake up and go to bed earlier during the weekday, and have shorter sleep durations on weekdays than weekends\(^{(19,38,49,50)}\). Children between seven and ten years of age who go to school in the morning display a higher frequency of naps; these children also go to the bed approximately one hour earlier than children who go to school in the afternoon\(^{(38)}\).

These behaviors indicate partial sleep deprivation during the week that is usually accompanied by sleep “com-
pensation” on the weekends, a pattern often observed in adolescents.\(^{57-59}\) However, the difference between weekend and weekday sleep schedules\(^{22}\) is less dramatic in children because of a natural predisposition to begin and end sleep earlier. In addition, parents have more influence on sleeping and waking times in young children.\(^{19,56}\)

The partial sleep deprivation and the sleep schedule irregularities that are related to a morning school schedule should not be found in children who naturally wake up early. However, bed-sharing, room-sharing, media use, and the family environment can all contribute to these alterations in sleep patterns. Some of these factors can have a positive effect on sleep habits; however, if used incorrectly or, in the case of media, used in excess or too close to bedtime, these factors can impair sleep because they prolong the waking state. In addition, these factors can increase nighttime exposure to light, acting on regulatory homeostatic and circadian sleep processes and leading to partial sleep deprivation and irregular waking and sleeping times.

If these social factors are minimized or used to positively influence sleeping habits, it may be possible to improve school performance by maintaining regular sleep schedules and decreasing or even avoiding partial sleep deprivation. Touchette et al.\(^{13}\) emphasize the importance of having children go to bed early and maintaining regular sleep schedules during both the weekdays and weekends, thus increasing sleep duration and maximizing development.

**CONCLUSION**

From the characterization of the SWC is observed that sleep patterns change during infancy such that children increase the duration of nighttime sleep and decrease the frequency of naps during the daytime. In addition, they tend to go to bed and wake up earlier.

The SWC of children can be influenced by social factors, such as bed-sharing, room-sharing, bedtime rituals, media use, as well as family and school environments, all of which contribute to a child’s routine and improve health and well-being. In some situations, however, these factors can delay the beginning of sleep and thus negatively interfere with the SWC of children. These factors are especially problematic when they are combined with a morning school schedule, resulting in partial sleep deprivation, sleep disturbances, and irregular bedtimes and waking times. These alterations in sleep habits can cause low school performance, obesity, attention-deficit/hyperactivity disorder, and are a predictor of insomnia in adolescence.

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