Routledge Handbook of Applied Sport Psychology
A comprehensive guide for students and practitioners
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The effect of sleep on athletic performance, and ways to improve the quantity and quality of sleep of athletes, has received little attention in the sport psychology literature. Nevertheless, most athletes and coaches will attest to the importance of feeling fresh and rested for both training and performing. Recent research points to the profound effect that sleep has, not only on athletic training and performance, but also on almost every aspect of athletes’ lives (e.g., interpersonal, academic, financial). Unfortunately, people have reported feeling much less satisfied with their sleep and in 2001 were sleeping one hour less per night than people in 1981 (Hicks, Fernandez, & Pellegrini, 2001; Hicks & Pellegrini, 1991).

The goal of this chapter is to provide sport psychology consultants with information and tools to increase the quantity and quality of athletes’ sleep. We will provide the rationale and content for sleep improvement education based on current sleep research as well as the first author’s experience working with thousands of individual athletes and teams in university and professional settings. We hope that after studying this chapter, the reader will have the resources to provide educational programs for athletes and a basis for further sleep research.

What is sleep and how is it measured?

Sleep has been defined in behavioral terms as a reversible behavioral state of perceptual disengagement from, and unresponsiveness to, the environment. During sleep we are to a great degree cut off from sensory information from the environment, but we can easily be awakened. At the same time we are cut off from the environment, our bodies are undergoing a great deal of activity and change compared to that observed in waking hours (Carskadon & Dement, 2005). Quality sleep refers to an athlete being able to fall asleep within 15–30 minutes of turning out the lights, experiencing few nighttime awakenings (less than 3), waking feeling refreshed, and functioning well throughout the day. A variety of assessments have been created to describe the changes that occur during sleep and form the basis for our definition of sleep. The most commonly used measures of sleep include: polysomnography, actigraphy, questionnaires, Multiple Sleep Onset Latency Test, and sleep logs. Each of these methods of quantifying sleep is described below.
Polysomnography

Polysomnography is a set of physiological recordings taken during sleep. The primary parameters assessed include: electroencephalography (EEG), which records electrical activity on the scalp associated with neural activity in the brain; electro-oculography (EOG), which records eye movement; electromyography (EMG), which records skeletal muscle activity; oximetry, which indirectly measures the oxygen saturation of a person’s blood; and respiratory airflow. EEG, EOG, and EMG are used to quantify the types of sleep experienced and oximetry and respiratory airflow are used to diagnose disordered breathing.

Based on polysomnography, normal sleep has been described as consisting of four non-rapid eye movement (NREM) stages and one rapid eye movement stage (REM). NREM sleep generally accounts for 75% of nighttime sleep and REM the remaining 25%. Sleep begins in the NREM stage and passes through four progressively deeper stages until the beginning of REM sleep. This cycle occurs approximately every 90 minutes throughout the night with the percentage of time spent in REM sleep becoming greater in comparison to NREM sleep toward the last third of the night.

Actigraphy

Although polysomnography is considered the gold standard in assessing sleep, newer technologies are being developed that are less expensive, do not tend to disrupt sleep, and capture daytime functioning. One such device is often referred to as an actigraph or actimeter. The actigraph typically is placed on the wrist and records movement with an accelerometer that is then analyzed by a microprocessor to determine how much time the user was awake or asleep (Ancoli-Israel, 2005). Some of the more sophisticated products also capture ambient light. Actigraphy has been shown to be a reliable and valid measure of normal sleep (Littner et al., 2003). Many practitioners use actigraphy in conjunction with polysomnography and sleep logs to inform their overall assessment of a person’s sleep.

Multiple sleep onset latency test

To assess how much physiological drive a person has to sleep, Carskadon and Dement (2005) designed a protocol containing a series of four to six opportunities to nap and measurement of how long it takes participants to fall asleep during each attempt throughout the day. Sleep latency in normal adults is from 10–20 minutes with pathological sleepiness as a mean sleep latency of 5–6 minutes. This shorter latency to sleep onset suggests that the individual is experiencing a strong drive to sleep during the day, which is likely the result of insufficient quality nighttime sleep.

Questionnaires

Standardized questionnaires are used to gather self-report data on a person’s nighttime sleep and daytime functioning. One of the most widely used self-report measures of sleep quality is the Pittsburgh Sleep Quality Index (PSQI; Buysse, Reynolds, Monk, Berman, & Kupfer, 1989). In this measure, clients answer a series of questions about their sleep over the previous month. One of the benefits of this type of measure is that it captures individuals’ subjective experiences of the quantity and quality of their sleep and provides normative data to
which each person can be compared. The PSQI measure provides a global score of sleep quality and seven subscales: sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbances, use of medication, and daytime dysfunction.

A commonly used self-report measure of daytime sleepiness is the Epworth Sleepiness Scale (Johns, 1991). On this scale, clients rate from 0 (slight) to 3 (high), the likelihood that they would doze in a variety of situations such as “sitting and reading,” “sitting and talking to someone,” and “in a car, while stopped for a few minutes in traffic.” This measure asks clients to report their behavior rather than their internal sense of tiredness. The Sleep Summary Worksheet (see Figure 29.1) contains the Epworth Sleepiness Scale, which is an indicator of whether a person’s sleep is of sufficient quality to sustain alertness during the day.
Sleep logs

Although the retrospective measures described above provide important information about clients’ recollections of their nighttime sleep and daytime sleepiness, prospective sleep logs help overcome some of the biases caused by memories being incomplete and selective. Sleep logs frequently are completed for two weeks and involve clients providing information on their sleep (e.g., how long it took to fall asleep, nighttime awakenings) and on factors that might impair sleep (e.g., caffeine consumption, anxiety, stressful activities engaged in before bed). Sleep log data are used both to inform recommendations for improving sleep as well as to help people understand how particular behaviors affect their sleep (see Figure 29.2).

Negative effects of poor sleep on performance

The duration and quality of an athlete’s sleep affects key psycho-physiological factors related to performance including: hypo- or hyper-arousal, inappropriate attention (e.g., too narrow, too broad, not sustained), decreased ability to process information, poor decision making, poor eating (e.g., overeating, eating high fat and sugary foods), poor emotional control, less endurance, inability to regulate energy levels (e.g., get up for an event), immune suppression, and poor memory (e.g., unable to remember coaches’ instructions: Reilly, 2009; Samuels, 2008). Even small decrements in functioning in these areas can have significant negative consequences for competitive athletes. It is all too common to see small lapses in judgment and less than optimal execution of a motor skill costing individuals and teams important championships.

Although sleep duration and quality appear to have direct effects on athletic performance, there are likely indirect effects as well. Sleep may increase or decrease athletes’ abilities to manage other important areas of their lives such as social relationships, academic tasks in the case of student athletes, or financial/business tasks in the case of professional or Olympic athletes. Figure 29.3 contains a theoretical model of how sleep may directly and indirectly affect competitive performance.

Although, in general, getting sufficient quality sleep contributes to effective training and performance, there may be individuals who experience a performance-enhancing effect of one night of poor sleep. For some athletes, the initial or next-day effect of getting several hours less sleep or having a more fitful sleep is to feel aroused and alert due to increased circulating stress hormones that are secreted into the blood to promote alertness. It is possible that the night-before nerves, which athletes often report before a big event, may in some cases increase the athletes’ arousal to a performance enhancing level and give them increased energy and the focus to succeed. One can think of the effects of several hours of sleep deprivation as similar to that of stress in that some stress can be motivating and performance-enhancing but over time can lead to burnout and increased errors. It is important to mention this caveat to athletes so that individuals who are having trouble sleeping before a big event do not worry so much about getting to sleep that they are not able to sleep at all.

Common sleep disorders

Although the primary focus of this chapter is on improving sleep among athletes who have poor quantity and quality of sleep because of modifiable lifestyle factors, it is important to
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<th>Tue</th>
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<td>Number of cigarettes smoked</td>
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**Complete during the night**

| Nighttime awaken #1 (time you woke up) | | | | | | | |
| Nighttime awaken #1 (minutes awake) | | | | | | | |
| Reason you awakened | | | | | | | |
| Nighttime awaken #2 (time you woke up) | | | | | | | |
| Nighttime awaken #2 (minutes awake) | | | | | | | |
| Reason you awakened | | | | | | | |
| Nighttime awaken #3 (time you woke up) | | | | | | | |
| Nighttime awaken #3 (minutes awake) | | | | | | | |
| Reason you awakened | | | | | | | |

**Complete upon awakening in the morning**

| Time you woke up in the morning | | | | | | | |
| Time you got out of bed | | | | | | | |
| # of minutes it took you to fall asleep last night | | | | | | | |
| How rested do you feel on a scale from (1=not at all rested to 10=very rested) | | | | | | | |
| Was the room you slept in comfortable (yes or no) | | | | | | | |

*Figure 29.2 Sleep log.*

have at least a basic understanding of the possible psychiatric and medical conditions that may be the cause of an athlete’s sleep problems and require medical treatment. Vaughn and D’Cruz (2005) should be referred to for examples of these types of conditions (e.g., insomnia that does not improve with lifestyle changes, pain, anxiety, depression, sleepiness, snoring, apneas [episodes of 10 seconds or more of not breathing]).
Necessary conditions for sleep

Sleep and wakefulness are under homeostatic and circadian alerting control. Homeostatic control refers to the phenomenon that the longer we are awake or not experiencing specific sleep stages, the greater the need to make up for the lost sleep or sleep stage. This need is also referred to as sleep drive. Circadian control of the sleep-wake rhythm refers to biochemical, physiological, and behavioral processes that encourage wakefulness. When these two regulatory mechanisms are working in synchrony, athletes are able to enter into sleep at regular times each evening, experience deeper stages of sleep (i.e., stages 3 and 4), and remain asleep until it is time to wake, and arise from bed feeling rested. Unfortunately, these two main regulators of sleep can be disrupted by physiological arousal, cognitions, and the environment. It is helpful for athletes to be aware that their cognitions, behaviors, and the environment can work with or against the homeostatic drive and circadian control. Table 29.1 shows theoretically how these factors can inhibit or facilitate sleep. A thorough understanding of how these factors function to promote sleep is central in providing effective educational programs for improving sleep. Each of these factors will be explained in more detail below and together form the theoretical model upon which lifestyle recommendations can be made to athletes.

Sleep drive

The drive to sleep is often referred to as a person’s sleep debt. This debt is built up by being awake and is paid back by sleeping. It is not possible to have zero sleep drive because as soon as one did, one would wake up and begin accruing sleep debt. The key understanding here is that it is not “intention to sleep” that promotes sleep, but, rather, the body’s drive to sleep that has been built up during wakefulness. Trying to sleep can actually be counter-productive because it generally increases arousal and inhibits sleep.

Table 29.1 Pattern of variables influencing sleep quality.

<table>
<thead>
<tr>
<th>Sleep drive</th>
<th>Circadian alerting</th>
<th>Somatic arousal</th>
<th>Cognitive arousal</th>
<th>Sleep environment</th>
<th>Sleep quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Dark, Quiet, Safe</td>
<td>High</td>
</tr>
<tr>
<td>Low</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>Light, Loud, Unsafe</td>
<td>Low</td>
</tr>
</tbody>
</table>
Further, falling asleep is not the major problem most people report. Many people routinely experience sleep debt due to curtailing sleep to engage in other priorities. The more common problem is nighttime awakenings and not entering into the deeper stages of restful sleep. Nighttime awakenings often occur as the sleep debt is paid back during the night and the sleep drive is diminished. A limited sleep drive may make it possible for internal (e.g., worries) or external factors (noises) to wake the athlete.

**Circadian rhythm**

The circadian rhythm, or body clock, coordinates the timing of most physiologic and behavioral processes. Some physiological processes need to be turned on at certain times of the day and night and others need to be turned off. For example, the digestive system needs to be less active in the night so that one can sleep (heavy meals before going to bed will disrupt sleep), and body temperature needs to be lowered during the night to help enter into deeper stages of sleep. Many sleep researchers have posited that circadian alerting works in opposition to the sleep drive to help one stay awake during the day and to consolidate sleep at night. Circadian alerting exerts its effect by creating biological changes that keep organisms alert and then withdrawing these changes to let the sleep drive take its effect.

It is now believed that our sleep–wake circadian rhythm is 10–15 minutes longer than 24 hours requiring us to reset our internal clock each day. The daily pattern of action of circadian alerting is to begin to alert the organism at about 9 a.m. and increasing alertness slowly until 9 p.m. with the greatest alerting effect occurring between 6 p.m. and 9 p.m. Circadian alerting decreases its action slowly, being almost completely withdrawn between 3 a.m. and 6 a.m. Figure 29.4 shows the general pattern of alerting that occurs during a 24-hour period and how this pattern compares with sleep drive (i.e., the opponent process model). One can see from the figure that the afternoon dip in energy (i.e., between 1 p.m. and 3 p.m.) is associated with the withdrawal of circadian alerting and increased sleep drive. Although most people experience changes in circadian alerting in the pattern described, it is important for athletes to understand their own particular cycles through observation and awareness.

![Circadian Rhythm Diagram](image-url)

Figure 29.4 Opponent process model of sleep. Reprinted with permission of Tracy Kuo (unpublished figure)
Physiological arousal

Sleep requires quiescence of the sympathetic component of the autonomic nervous system and activities and substances that affect this system. Muscle tension needs to be reduced to a minimum, respiration needs to slow, and one needs to feel comfortable and safe enough in one's environment to encourage sleep. Conversely, sympathetic nervous system activity (e.g., increased muscle tension and stress hormones) inhibits sleep. Commonly referred to as the fight-or-flight response, physiological arousal is associated with alertness and a physiological state of preparing for and taking action. The flight-or-flight response works in opposition to sleep.

Cognitive arousal

Attention to, and processing of, the external and internal world needs to diminish for sleep to occur. One of the biggest barriers to this process of withdrawing from oneself and the world is excessive thoughts about problems in one's life. Thinking about losses, fears, or injustices interferes with sleep by increasing cognitive activity, effort, vigilance, or arousal. Problem solving and preparation for future action are incompatible with the type of diffuse attention required to enter into sleep. For many busy people, as soon as their bodies begin to relax, their minds begin to ruminate about a flood of problems to be solved, which only serves to heighten their alertness. For other people, being in bed is one of the only times in the day that they feel is "their own" time and they resist the urge to sleep so they can enjoy some time of solitude. Another type of cognition that can interfere with sleep arises when athletes worry that they will not be able to fall asleep and get the rest they need to perform well the next day.

Environment

The sleep environment can have a positive or negative effect on sleep. If the environment within and around athletes is relaxed, dark, quiet, and comfortable (neither too hot nor too cold), they will have a better chance of experiencing restful and restorative sleep. The key principle operating here is that the environment needs to be safe and not draw attention away from sleeping.

Sleep management guidelines

Recommendations for lifestyle behaviors relate to the necessary conditions for sleep described above. It is important to emphasize that not every recommendation will apply to every person and that it is up to each athlete to apply the sleep management guidelines and evaluate how each one serves to promote sleep for them.

Sleep drive

Recommendation: Do not go to bed until you feel sleepy.
Rationale: If athletes have not accrued sufficient sleep drive, they will not be able to fall asleep even if they are relaxed, comfortable, and in a safe sleep environment. A common problem is for athletes to go to bed several hours earlier than usual the
night before a big event to try to get extra rest. This tactic often leads to athletes lying in bed and worrying about not being able to sleep and the negative effects this will have on their performance.

Recommendation: Do not take any daytime or evening naps.
Rationale: Daytime naps reduce sleep drive leading to delays in sleep onset and nighttime awakenings. The exception to this recommendation is if daytime naps of less than 1 hour improve recovery after training, are an established sleep pattern, and do not impair nighttime sleep.

Circadian alerting

Recommendation: Expose the body to as much light as is practical during the day.
Rationale: Exposure to light (especially sunlight) signals circadian alerting to maintain its alerting effects. Conversely, withdrawal of light in the evening helps the circadian alerting to withdraw and permit sleep.

Recommendation: Get up and go to bed at approximately the same time (within 1 hour) every day.
Rationale: Maintaining a consistent schedule will help the circadian alerting facilitate alertness during the day and withdraw its effects in the evening. It is not uncommon for athletes to go to sleep after 2 a.m. in the later days of the week only to find that they are not able to fall asleep when they try to sleep before midnight in the earlier days of the week. Moving the sleep-and-wake schedule is equivalent to creating the problems of jet lag every week.

Recommendation: Avoid consuming excess fluids prior to sleeping and avoid eating in the middle of the night.
Rationale: Digestion and elimination are shut down by the circadian clock to promote sleep. Eating late at night or during the night can lead to increased digestion and the alerting activity of the circadian clock.

Recommendation: Do not drink alcohol 2 hours before bedtime.
Rationale: Alcohol may make athletes fall asleep quickly but it reduces the quality (especially REM) sleep they get during the night.

Recommendation: Eat on a consistent schedule during the day and early evening. Do not skip meals. Include healthy food in your diet such as fruits, vegetables, legumes, and grains, and limit refined and sugary foods.
Rationale: Circadian alerting is associated with eating. Healthy eating is associated with overall better physiological functioning responsible for circadian alerting activities.

Recommendation: Do not exercise within 4 hours of bedtime.
Rationale: Exercise raises core body temperature leading to alertness. Core body temperature does, however, tend to decrease within 4 hours of exercise.

Somatic arousal

Recommendation: Do not eat or drink anything containing caffeine or other stimulants after 4 p.m., or within six hours of bedtime. Caffeine increases arousal. Learn all of the foods (e.g., chocolate), drinks (e.g., coffee, tea, soda), and medications (e.g., some over-the-counter cold, headache, and pain relief medications) that contain caffeine and other sympathomimetic substances
(e.g., pseudoephedrine, phenylpropanolamine). Some athletes are sensitive to caffeine and other stimulants and need to eliminate consumption to facilitate sleep. Avoid tobacco in the evening.

Rationale: Caffeine, tobacco, and several over-the-counter medications are substances that increase sympathetic nervous system activation and inhibit sleep.

Recommendation: Engage in pleasant, stress-reducing activities, and nurturing relationships.

Rationale: These activities help buffer the effects of stress that can lead to sleep-inhibiting hyper-arousal.

Recommendation: Engage in relaxation training (e.g., progressive muscle relaxation, autogenic training) during the day and before bed.

Rationale: Many athletes have learned techniques for reducing arousal that can be used to facilitate sleep. Athletes need to be careful, however, that the relaxation strategies they have learned to reduce arousal before or during competition do not become associated with sleep. It is often beneficial for athletes to use different relaxation training techniques and strategies to reduce arousal before going to bed than they use in relation to their sports performance. If a clear distinction between relaxing for sleep and relaxing for performance is not made, an athlete may become relaxed and alert while trying to sleep or relaxed and drowsy when trying to perform. It can take some practice to learn to create and distinguish between these different states.

Cognitive arousal

Recommendation: Do not try to make yourself sleep.

Rationale: Trying to sleep is incompatible with the withdrawal of attention and effort required to enter into sleep. Athletes should tell themselves to just let sleep happen and console themselves with the notion that they will eventually sleep, especially as their sleep drive increases. This letting go of effort often leads to sleep.

Recommendation: Avoid working on unpleasant or frustrating tasks just prior to bedtime.

Rationale: It is helpful to reduce cognitive activity that can interfere with sleep prior to going to bed.

Recommendation: Use the last hour prior to bedtime to engage in activities that are enjoyable and relaxing (e.g., taking a warm shower). Take time to wind down from the activities of the day.

Rationale: A pre-bed routine functions to prepare the body and mind for sleep. Similar to pre-performance routines athletes use to increase arousal and narrow focus before a competition, pre-bed routines can help athletes decrease arousal and draw attention away from the concerns of the day.

Recommendation: If worries are making it difficult to fall asleep or stay asleep, consider scheduling a structured time to write about worries and concerns a few hours before going to bed. The act of writing down worries helps some people put them out of their minds and stops them from intruding on their sleep.

Rationale: Writing down worries may reduce the likelihood that an athlete will wake up during the night because of an intrusive worry.
Sleep environment

Recommendation: If you go to bed and remain awake for longer than 20 minutes, get out of bed and do something boring (e.g., sit in a chair). Do not return to bed until you feel sleepy. If you return to bed, but again find after 20 minutes that you cannot fall asleep, repeat the instructions.

Rationale: Athletes need to associate the bed with sleeping so that as soon as they enter the bed, body and mind prepare to sleep.

Recommendation: The bed should serve as a cue for sleep. Do not engage in any activity (e.g., watching TV, reading, listening to a radio) other than sleep (and sex) in bed.

Rationale: Athletes need to associate the bed with sleeping as much as possible.

Recommendation: Make the sleep environment conducive to sleep. Arrange for a comfortable temperature and minimal levels of sound. Avoid the use of the radio, stereo, or television to promote sleep. Darken the room as much as possible at night. Make the bedroom feel as safe as possible (e.g., lock windows and doors).

Rationale: Reducing environmental factors that may arouse the athlete from sleep promotes sleep.

Conclusions

Improving the sleep of athletes is a low-cost intervention that sport psychology consultants can use to support the mental and physical training of the athletes with whom they work. Nevertheless, educational programs like the one described in this chapter should not be promoted as a treatment for sleep disorders. Such treatment requires a thorough medical and psychological evaluation and treatment plan. The effects of sleep on athletic performance and the life of the athlete are significant. The challenge for sport psychology consultants is to educate the sports community about the available strategies for improving the sleep of athletes, and, one hopes, the success of both athletes and coaches. We hope that all sport psychology consultants will consider improving sleep as an important part of their intervention repertoires. See Box 29.1 for the main take-home messages of this chapter.

Box 29.1

Take-home messages about sleep

- Sleep influences key biopsychosocial factors related to sports performance.
- Quality and quantity of sleep are determined by the interaction of sleep drive, circadian alerting rhythm, cognitive and somatic arousal, and the sleep environment.
- Implementing behavioral sleep management guidelines can improve the quantity and quality of sleep.
Athletes should leverage their sleep drive to improve sleep by only going to bed when they feel sleepy and not taking daytime or evening naps that interfere with falling asleep or staying asleep.

Athletes should entrain their circadian alerting rhythm to withdraw and allow them to sleep by exposing themselves to light as much as possible in the day, maintaining a consistent sleep–wake schedule every day of the week, avoiding excessive fluids before bedtime, refraining from drinking alcohol 2 hours before bedtime, eating consistently throughout the day and avoiding exercise 4 hours before bedtime.

Athletes should reduce their somatic arousal by reducing caffeine, tobacco, and other sympathomimetics consumption, engaging in pleasant activities, and practising relaxation training techniques.

Athletes should reduce their cognitive arousal by not trying to make themselves sleep, avoiding frustrating tasks just prior to bedtime, engaging in relaxing and pleasurable activities prior to bed, and managing worry.

Athletes should make the sleep environment safe, comfortable, and quiet.

References


